COPY FOR MR. J. ALLAN ROSS

HYDRO-ELECTRIC INQUIRY COMMISSION

ENGINEERING DATA

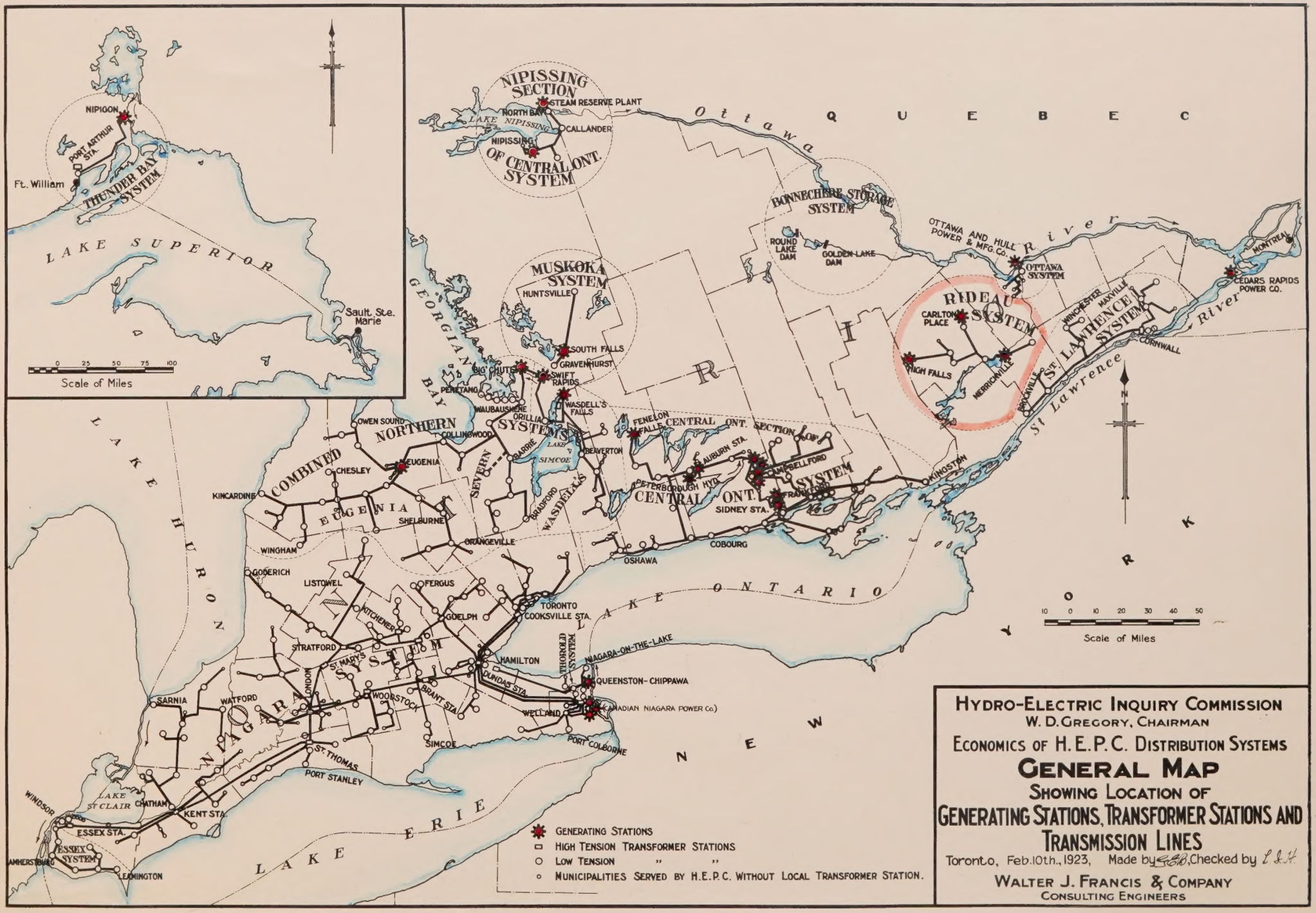
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

STUDY OF RIDEAU SYSTEM

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

RIDEAU SYSTEM


HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
GENERAL MAP
SHOWING LOCATION OF
GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES
Toronto, Feb. 10th., 1923, Made by G.E.B., Checked by L.S.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS
GENERATING STATIONS
HIGH TENSION TRANSFORMER STATIONS
LOW TENSION " "
MUNICIPALITIES SERVED BY H.E.P.C. WITHOUT LOCAL TRANSFORMER STATION.
Scale of Miles
NIPISSING SECTION OF CENTRAL ONT. SYSTEM
STEAM RESERVE PLANT
NORTH BAY
CALLANDER
LAKE NIPISSING
NIPISSING
MUSKOKA SYSTEM
HUNTSVILLE
SOUTH FALLS
GRAVENHURST
BIG CHUTE
SWIFT RAPIDS
WASDELL'S FALLS
PENETANG
WAUBAUSHENE
ORILLIA
BARRIE
LAKE SIMCOE
BEAVERTON
BONNECHERE STORAGE SYSTEM
ROUND LAKE DAM
GOLDEN LAKE DAM
OTTAWA AND HULL POWER & MFG. CO.
OTTAWA SYSTEM
RIDEAU SYSTEM
CARLTON PLACE
HIGH FALLS
MERRICKVILLE
BROCKVILLE
ST. LAWRENCE SYSTEM
WINCHESTER
MAXVILLE
CORNWALL
CEDARS RAPIDS POWER CO.
MONTREAL
Ottawa River
St Lawrence River
QUEBEC
NEW YORK
LAKE ONTARIO
LAKE ERIE
LAKE HURON
LAKE SUPERIOR
GEORGIAN BAY
NIPIGON
PORT ARTHUR STA.
Ft. William
THUNDER BAY SYSTEM
Sault Ste. Marie
Scale of Miles
OWEN SOUND
NORTHERN SYSTEM
COLLINGWOOD
COMBINED EUGENIA SYSTEM
CHESLEY
EUGENIA
KINCARDINE
SHELBURNE
WINGHAM
GODERICH
LISTOWEL
SEVERN
ORANGEVILLE
BRADFORD
WASDELL'S
FENELON FALLS
CENTRAL ONT. SECTION OF
AUBURN STA.
PETERBOROUGH HYD.
BELLFORD
CENTRAL ONT. SYSTEM
SIDNEY STA.
FRANKFORD
KINGSTON
COBOURG
OSHAWA
FERGUS
GUELPH
KITCHENER
STRATFORD
ST. MARYS
LONDON
TORONTO
COOKSVILLE STA.
THOROLD SYSTEM
HAMILTON
DUNDAS STA.
NIAGARA-ON-THE-LAKE
QUEENSTON-CHIPPAWA
(CANADIAN NIAGARA POWER Co.)
WELLAND
PORT COLBORNE
NIAGARA SYSTEM
SARNIA
WATFORD
WOODSTOCK
BRANT STA.
SIMCOE
ST. THOMAS
PORT STANLEY
WINDSOR
LAKE ST CLAIR
CHATHAM
KENT STA.
ESSEX STA.
ESSEX SYSTEM
AMHERSTBURG
LEAMINGTON

To face frontispiece

General Map Showing Location of

Generating Stations, Transformer Stations and Transmission Lines

of the

Hydro-Electric Power Commission of Ontario

The area outlined in red shows the

Rideau System.

INDEX TO RIDEAU SYSTEM

Subject	Page
Preamble	1
Evolution and Development of the System	4
Description of the System	10
General	10
Generating Stations and Other Sources of Power Supply	11
(a) High Falls Plant	11
(b) Carleton Place Plant	14
(c) Storage Reservoirs	15
(d) Merrickville Plant, - Rideau Power Company	15
(e) Undeveloped Power Sites, Rideau System	16
(f) Miscellaneous Power Plants in the District	16
Transmission Lines	18
Transforming and Distributing Stations	18
Local Distributing Systems	19
Characteristics of Market	20
Population Served and Percentage of Consumers to Population	20
Growth of Market and Ultimate Sources of Power Supply	21
Capital Costs	23
General	23
Power Data	27
Developed Horse-power	27
Purchased Horse-power	29
Developed plus Purchased Horse-power	29
Billed Horse-power	29
Average Monthly Peaks	30
Maximum Yearly Peaks	30
Capital Costs per Horse-power Developed	30
Total Revenues	33

INDEX TO RIDEAU SYSTEM

Subject	Page
Total Costs of Power	33
Power Purchased	35
Operating Costs	35
Maintenance	35
Overhead and General Expense	35
Interest, Renewals, Sinking Fund and Contingencies	36
Percentage Costs of Power	36
Analysis of Reserve Accounts	39
Renewals Account	39
Sinking Fund	44
Reserve for Contingencies	44
Discussion of Deficits and Surpluses	45
Revenues and Costs per Horse-power per Annum	46
Revenues per Horse-power per Annum	46
Annual Costs per Horse-power	47
Kilowatt-hour Data	52
Summary	53

(Illus.)

LIST OF ILLUSTRATIONS

RIDEAU SYSTEM

Subject	Page
General Map Showing Location of Generating Stations, Transformer Stations and Transmission Lines of the Hydro-Electric Power Commission of Ontario	Frontispiece
Rideau System, Map showing Location of Generating Stations, Transformer Stations and Transmission Lines	12
Diagram of Progressive Capital Costs	25
Diagram of Horse-power Data	28
Diagram of Capital Costs per Horse-power Developed	31
Diagram of Total Annual Revenues	34
Diagram of Total Annual Costs	37
Diagram of Total Annual Costs Subdivided by Percentages	38
Diagram of Reserves for Renewals	40
Diagram of Cost per Horse-power per Annum, Various H.P. Bases	48
Diagram of Subdivided Costs per Annum per Horse-power Developed	49
Diagram of Subdivided Costs per Annum per Horse-power Billed	51

WALTER J. FRANCIS & COMPANY.
COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

Toronto, Ontario,

March 24th, 1923.

Hydro-Electric Inquiry Commission,
W. D. Gregory, Esq., Chairman,
T O R O N T O, Ontario.

re Studies of Engineering Economics of the
Rideau System of the
Hydro-Electric Power Commission of Ontario

Mr. Chairman and Gentlemen,-

In accordance with the letter of your Commission under date of November 4th, 1922, and your confirmation of the general instructions under date of November 15th, 1922, a study has been made of the engineering economics of the Rideau System of electrical generation and distribution operated by the Hydro-Electric Power Commission of Ontario. The work has been done under the direct personal supervision of Mr. Frederick B. Brown, M. Sc., M.E.I.C., a partner in the firm of Walter J. Francis & Company, in accordance with your instructions.

The subject has been discussed with Mr. Commissioner R. A. Ross in detail, and, generally, with Mr. Bower, the Secretary of your Commission, and constant communication has been maintained with the officials of the Hydro-Electric Power Commission of Ontario.

The reports of Messrs. Price, Waterhouse & Co. have been used as the basis of the financial figures given herein, and reference has been made to the records of the Hydro-Electric Power Commission of Ontario where it was necessary to do so to prepare the diagrams.

It is understood that it is not within the scope of the instructions to examine into any of the legal aspects of the System nor discuss any of the Acts of the Legislature relating to it.

The necessary technical data has required considerable preparation as much of it is only available in the operating records of the Hydro-Electric Power Commission of Ontario. The printed reports contain a part, but these have had to be supplemented by interviews with various officials, and by searching the voluminous records both at the head office in Toronto and elsewhere.

The general plan under which the report of the studies is presented may be outlined as follows:

(1) A short review of the history and evolution of the System.

(2) A brief physical description of the System.

(3) A brief discussion regarding the characteristics of the local market.

(4) A discussion of progressive capital costs.

(5) Statistics regarding progressive revenues for various classes of service, with discussion thereon.

(6) Statistics regarding progressive operating costs and fixed charges, with discussion thereon.

(7) Statistics showing progressive and accumulated deficits or surpluses, with discussion thereon.

(8) Analysis of progressive operating records and of unit revenues per horse-power per annum and of unit costs per horse-power per annum.

(9) A brief discussion of the various important points concerning the System.

The report included herewith as pages 4 to 54 inclusive refers in detail to that portion of the activities of the Hydro-Electric Power Commission known as the Niagara System. References are made to the inter-connection of this System with other systems.

Throughout the report diagrams have been included in the order of the text, while the map included as a frontispiece shows the System generally and its geographical relation to all the other systems operated by the Hydro-Electric Power Commission of Ontario.

COPY

RIDEAU SYSTEM

Frederick B. Brown, M. Sc.

Evolution and Development of the System.

The Rideau System, as at present constituted, has resulted from the efforts of the municipalities of Perth, Smith's Falls and Carleton Place, which were desirous of having a source of power which would be adequate to take care of their industrial growth. During the years 1916 and 1917 these municipalities began to negotiate for a supply of power from the Hydro-Electric Power Commission of Ontario. At that time the municipalities in this district, now comprised in the Rideau System, were supplied by small electric power plants which were either municipally owned or were the property of small private companies. A number of these small hydro-electric plants situated on the Mississippi, Rideau and Tay Rivers were very seriously affected by low water periods, and several auxiliary steam plants were required to maintain service. The Rideau Power Company at Merrickville was the only company with sufficient excess capacity to consider the sale of power at any distance from the generating station.

The Hydro-Electric Power Commission of Ontario, after investigating the requirements of the district and considering the various possible sources of power supply, apparently came to the conclusion that the best way to supply the municipalities in this district was to develop the power locally, and steps were taken to purchase the privately owned rights in the undeveloped

power site at High Falls on the Mississippi River.

The Order-in-Council permitting the purchase was dated July 4th, 1918; it provided for the purchase of the land and water rights, which amounted to $10,478.00, and covered the following:

"1. The acquiring by purchase, lease or otherwise of the necessary lands, waters, water privileges and water powers for the developing of the said water power.

"2. The purchase of the necessary material and equipment for construction of plant for generation of 3,000 horse-power of electrical energy, and for its transformation for transmission to the various municipalities in that district.

"3. The purchase of necessary material and equipment for the construction of transmission lines and transformer stations for the delivery of the said power to the various municipalities in that district."

During this period, 1917 to 1918, the municipalities of Perth, Smith's Falls and Carleton Place, with the aid of the Commission, entered into negotiations for the purchase of the local power plants from the private companies which owned and operated them.

In Perth, after a valuation had been made by the engineers of the Hydro-Electric Power Commission, the town took over the remaining two of the three local hydro-electric plants and the steam plant, the distributing systems, and also the water works. In each of the two hydro-electric plants acquired, known as the "Badour" and the "Glen Tay", the 133-cycle generators were later replaced by the installation of one 300-kilowatt, 3-phase, 60-cycle, 2,200-volt generator, and the steam-electric plant was discarded. The third local hydro-electric plant was already owned by the municipality and was used for street lighting only.

In Smith's Falls the plants and distributing systems of the Smith's Falls

Electric Company and the Citizens Electric Company were taken over by the municipality and operated as a self-contained system until a supply of power was obtained from the Hydro-Electric Power Commission. These plants are equipped with 60-cycle generators and can be operated in parallel with the rest of the System.

On January 25th, 1918, the Commission entered into an agreement with the Rideau Power Company, Limited, at Merrickville for the purchase of a supply of power. The plant was stated to have a capacity of 1000 horse-power, and the Commission agreed to purchase a minimum of 500 horse-power for 20 years at $14.00 per horse-power per annum; the quantity of power to be increased, if required, until the ultimate supply reached the total available capacity of the plant after first supplying the requirements of the municipality of Merrickville, which also purchases power direct from the Company.

Since the autumn of 1918 the Commission has been supplied with some power from this Company, the amounts averaging 669 horse-power in 1919, 479 horse-power in 1920, 363 horse-power in 1921, and about 400 horse-power in 1922. As the Company could not fulfil its obligations to supply a minimum of 500 horse-power after providing for the Merrickville requirements, the Commission did not pay for the full 500 horse-power, but only for the amount actually taken as above.

Exhibit IV of the report of Price, Waterhouse & Co. dated November 7th, 1922, Hydro-Electric Inquiry Commission file 197-a, gives full details of the contract.

In 1918 the municipality of Carleton Place secured an option for the purchase of the local hydro-electric power plant on the Mississippi River

at the outlet of Mississippi Lake, and the distributing system, both of which were owned and operated by M. Brown & Sons. These properties were purchased by the municipality on May 1st, 1919, and the power plant was taken over on May 20th, 1919, by the Hydro-Electric Power Commission of Ontario to be used as an extra source of supply for the municipalities of the Rideau System, and to give control of the river at Carleton Place. This control, it is stated by the engineers of the Commission, is very essential for the most economical operation of the development at High Falls, by using the Mississippi Lake storage for regulation of flow for the power owners downstream, and using the storage above High Falls irrespective of those power users below Carleton Place.

Pending the development of High Falls, which was built between October, 1918, and June, 1920, power was obtained by the Hydro-Electric Power Commission of Ontario from the Rideau Power Company at Merrickville, under the contract mentioned above, to serve the municipalities of the Rideau System. A 26,400-volt transmission line between the generating station at Merrickville and Smith's Falls was constructed, being tested and put into service on September 15th, 1918, and the Town of Smith's Falls was supplied with power from that date. This marked the beginning of the operation of the Rideau System. In April, 1918, work was started on a transmission line from Smith's Falls to Perth, and on February 18th, 1919, Perth began to take power from the Commission. In 1918 a line was constructed from Perth to High Falls, a distance of twenty-one miles, this line being at first used to transmit power from the Merrickville generating station to High Falls for construction purposes and later to carry power from the High Falls plant to the Rideau

System. On May 1st, 1919, the municipality of Carleton Place took possession of the above-mentioned generating and distributing system then owned and operated by H. Brown & Sons. The purchase price is stated to be $100,000.00. The Hydro-Electric Power Commission arranged with the municipality of Carleton Place that the municipality should retain the distributing system and that the Commission should take over the generating plant for $60,000.00. An Order-in-Council dated May 20th, 1919, authorized the Hydro-Electric Power Commission of Ontario to purchase this plant, which, as already stated, is located on the Mississippi River just below Mississippi Lake and has a capacity of about 530 horse-power at 80 per cent. power factor, according to the report of Mr. Walter J. Francis, C.E., entitled "Principal Characteristics of H. E. P. C. Plants", and addressed to the Hydro-Electric Inquiry Commission. The purchase price of $60,000 included 75 shares in the Mississippi River Improvement Company, Limited, of a par value of $100.00 per share, upon which $4,125.00 had been paid by the former owners, representing stock assessments made to that time. In Exhibit V of the report of Price, Waterhouse & Co. dated November 7th, 1922, Hydro-Electric Inquiry Commission file No. 197-a, considerable information is given concerning this Company, which owns and operates the storage reservoirs at the headwaters of the Mississippi River.

When this hydro-electric plant was purchased by the Commission, the municipality of Carleton Place became a partner in the Rideau System and was supplied with the full capacity of the development. A transmission line was constructed during the summer of 1919 from Carleton Place to High Falls and completed the connection between the development at Carleton Place and

the Rideau Power Company's plant at Merrickville.

On May 1st, 1920, the first unit of the High Falls development was put into service, and on June 26th the two other units were made available, making the rated capacity of this plant 2,800 electrical horse-power at 80 per cent. power factor.

During the latter part of 1919 and the early part of 1920 the municipalities of Smith's Falls and Perth were greatly handicapped by the shortage of power at Merrickville due to lack of water in the Rideau Canal. This necessitated the temporary operation of the steam plant at Smith's Falls, resulting in a large increase in operating expenses. The shortage was relieved when the first unit at High Falls was put into service on May 1st, 1920.

At October 31st, 1921, the Commission was supplying power to four municipalities, the village of Lanark having been added to the System in September, 1921. Lanark is served by a 2,400-volt line from the distributing station in the village of Balderson through which the 26,400-volt line between Perth and High Falls passes. Since October, 1921, the System has continued to expand, a rural class distributing station having been constructed to supply the village of Kemptville, the village of Balderson being supplied from the Balderson station. On March 1st, 1922, the Commission agreed to supply the Grenville Crushed Rock Company, Limited, of the town of Smith's Falls, with 650 electrical horse-power at $45.00 per horse-power per annum for a period of four years from April 1st, 1922. This agreement may be extended for further terms of one year each, upon the mutual agreement of both parties.

During the winter of 1922-1923 extreme low water conditions have existed on the Mississippi River, resulting in a shortage of several hundred horse-power at the High Falls plant and at Merrickville. This made it necessary to operate the hydro-electric plant at Carleton Place and one of the municipal plants at Smith's Falls.

To prevent the recurrence of such shortage of power at the High Falls plant, the Hydro-Electric Power Commission of Ontario proposes that additions to and improvements in the water storage be made by building new dams at the lakes at the headwaters of the Mississippi River during the year 1923.

COPY

Description of the System.

General.

The Rideau System lies north and west of the St. Lawrence System and south and west of the Ottawa System. It extends about fifty miles north and south, and fifty miles east and west, and includes within its boundaries the County of Lanark and parts of the Counties of Grenville, Leeds, Frontenac, Renfrew and Carleton.

The map included as a frontispiece shows the whole of the transmission systems of the Hydro-Electric Power Commission, with the location of generating stations, high voltage transformer stations, high voltage transmission lines and low voltage transformer stations, clearly indicated, and shows the various systems in their relation to one another. The tinted portion of the map indicates the Rideau System.

The map included as page 12 shows the Rideau System on a larger scale than the frontispiece, as well as the Ottawa System, the St. Lawrence System, and the easterly part of the Central Ontario System, which are adjacent to the Rideau System and which at some time may be interconnected with it. There are also shown a table of the Mississippi River storage reservoirs, the drainage area of the Mississippi River, and the names of the principal centres concerned.

Speaking broadly, the Rideau System consists of one 2,800 horse-power hydro-electric generating plant on the Mississippi River at High Falls, one 530 horse-power generating station on the same river at Carleton Place, together with transmission lines feeding six municipalities and one company. A certain amount of rural load will probably be supplied in the near future.

Generating Stations and Other Sources of Power Supply.

(a) High Falls Plant.

The High Falls plant, developed by the Hydro-Electric Power Commission of Ontario, is the largest generating station on the Rideau System. It is located on the Mississippi River in the southern part of Lanark County, about twenty-five miles north-east of Perth and one-half mile above Dalhousie Lake. The watershed area of the Mississippi above this site is about 450 square miles. The Construction Department of the Commission, which handled the whole of the development, built a concrete dam about 510 feet long and 25 feet maximum height across the head of the falls, providing a local pondage of about 300,000,000 cubic feet available for daily peak operation. An intake channel, about 8 feet wide at the bottom, extending for a distance of 247 feet upstream

The map included on page 12 shows the Rhines System on a larger scale than the previous, as well as the River System, like it, [illegible] and the majority part of the natural drainage system, which are adjusted to the Rhines System and which at some time may be interconnected with it. There are also large a basin of the Kinsalebegin River system, the [illegible] of the Blackwater River, and its source at the Galtee Mountains.

Finally, the Rhines System consists of one 2,400 [illegible] Tipperary-Limerick connecting canal on the Kinsalebegin River at High Rock, one 80 [illegible] connecting canal on the same river at Galtee Plain, together with tunnelling from Galtee Valley via the Mulkeagh Valley and the Knockfin, a branch canal of about 12 miles that will [illegible] in the near future.

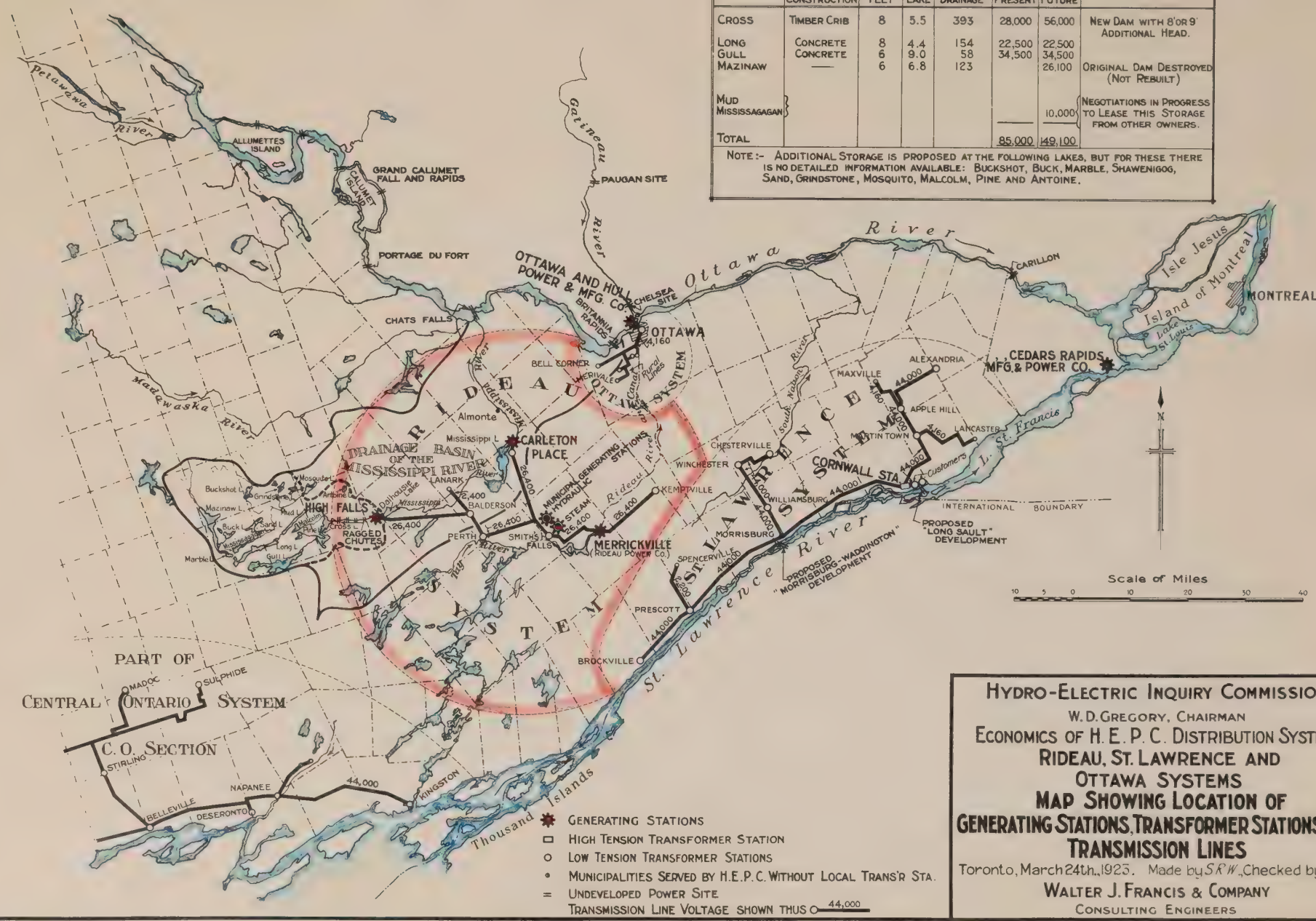
Irrigation Storage and Hydro-electric Potential of Lower Rhines

(a) Main Valley Dams.

The High Rock Dam, designed by the Hydro-Electric Power Commission of Ireland, is the largest generating station on the Rhines System. It is the main on the Kinsalebegin River in the southern part of Limerick County, where hydro-electric power originally or which has remarkable water catchment area. The Kinsalebegin area of the Blackwater where this dam is about 400 square miles. The Kinsalebegin catchment of the Blackwater, which includes the main of the Galtee Mountains, with a mountain rain about 50 feet deep, has a max height across the base of the Valley, providing a local storage of about 200,000 cubic feet available for daily peak operation. An intake tunnel, about 2 [illegible] in diameter, connects the [illegible] a distance of [illegible]

TABLE OF MISSISSIPPI RIVER STORAGE RESERVOIRS							
NAME OF LAKE	DAM TYPE OF CONSTRUCTION	STORAGE HEAD. FEET	AREAS: SQ. MILES LAKE	AREAS: SQ. MILES WATERSHED DRAINAGE	STORAGE-ACRE FT. PRESENT	STORAGE-ACRE FT. FUTURE	REMARKS
CROSS	TIMBER CRIB	8	5.5	393	28,000	56,000	NEW DAM WITH 8' OR 9' ADDITIONAL HEAD.
LONG	CONCRETE	8	4.4	154	22,500	22,500	
GULL	CONCRETE	6	9.0	58	34,500	34,500	
MAZINAW	——	6	6.8	123		26,100	ORIGINAL DAM DESTROYED (NOT REBUILT)
MUD MISSISSAGAGAN					——	10,000	NEGOTIATIONS IN PROGRESS TO LEASE THIS STORAGE FROM OTHER OWNERS.
TOTAL					85,000	149,100	

NOTE:- ADDITIONAL STORAGE IS PROPOSED AT THE FOLLOWING LAKES, BUT FOR THESE THERE IS NO DETAILED INFORMATION AVAILABLE: BUCKSHOT, BUCK, MARBLE, SHAWENIGOG, SAND, GRINDSTONE, MOSQUITO, MALCOLM, PINE AND ANTOINE.



HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

RIDEAU, ST. LAWRENCE AND OTTAWA SYSTEMS

MAP SHOWING LOCATION OF GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES

Toronto, March 24th, 1923. Made by S.R.W., Checked by W.J.F.

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

(12)

from the gate-house section at the north end of the dam, has been excavated. The gate-house substructure, which is built as part of the dam, is 27 feet wide by 30 feet long, and has a height of 22 feet to the bottom of the superstructure. Its water section narrows down to a reinforced concrete elbow 10 feet in diameter, which connects to a continuous wood-stave pipe of the same size. The water is led through this pipe a distance of 320 feet to the turbines which operate at a mean net head of 78 feet and a minimum net head of 76 feet. The gross head is about 81.5 feet. The power house, situated on the river bank, is about 94 feet long by 62 feet wide, and is built entirely of concrete. The three horizontal, double-runner, double discharge turbines were purchased at a low cost from the Hannawa Falls Power Company of Potsdam, New York, and were built by the James Leffel Company at Springfield, Mass. They are rated at 1,200 horse-power each at 300 revolutions per minute under a head of 80 feet.

One of the units is coupled to one 875-K.V.A., 3-phase, 60-cycle, 4,160-volt horizontal generator; and the other two units are each coupled to two 350-K.V.A., 3-phase, 60-cycle, 4,160-volt horizontal generators, these being directly connected to opposite ends of the same turbine shaft, these machines having been purchased with the turbines. Three 750-K.V.A., station transformers step up the voltage from 4,160 to 25,400 volts for transmission to the distributing stations at Balderson, Carleton Place, Kemptville, Perth and Smith's Falls.

The capacity of this plant is approximately 2,800 electrical horse-power at 80 per cent. power factor in accordance with the ordinary rating of the Hydro-Electric Power Commission of Ontario. It is stated that it requires about 540 cubic feet of water per second when operating at maximum peak

The gate-house structure, which is built as part of the dam, is 77 feet wide by 40 feet long, and has a height of 13 feet to the bottom of the superstructure. Its water section rests down in a reinforced concrete elbow 30 feet in diameter, which connects to a continuous wood-stave pipe of the same size. The water is led through this pipe a distance of 847 feet to the turbines which operate at a head of 73 feet and a maximum net head of 70 feet. The gross head is about 81.5 feet. The power house, situated on the river bank, is about 94 feet long by 62 feet wide, and is built entirely of masonry. The three horizontal, double-runner, double discharge turbines were [illegible] York, and were built by the James Leffel Company at Springfield, Ohio. They are rated at 1,500 horse-power each at 300 revolutions per minute under a head of 60 feet.

One of the units is coupled to one [illegible], 3-phase, 60-cycle, 4,160-volt horizontal generator; and the other two units are each coupled to two [illegible] generators, [illegible] horizontal exciters, [illegible] ly connected to opposite ends of the same turbine shaft, these machines having [illegible] with the generator. These [illegible], through [illegible] up the voltage from 4,160 to 33,000 volts for transmission to the distributing stations at Baldwinsville, Skaneateles Falls, Jamesville, Marcellus and Smith's Mills.

The capacity of this plant is approximately 3,000 electrical horse-power at 60 per sec. power factor in accordance with the ordinary rating of the hydro-electric power generation on ontario. It is stated that it requires about 500 cubic feet of water per second when operating at maximum peak

capacity.

(b) Carleton Place Plant.

Besides the High Falls plant the Rideau System includes a hydro-electric power development located on the same river, the Mississippi, at Carleton Place. This plant is owned by the Commission and is maintained as a stand-by. A dam 400 feet long and varying in height from 3 feet to 12 feet impounds the water over an area stated to be approximately 10 square miles. The water is led from the dam by means of four open penstocks each 14½ feet wide and 24 feet long to the power house. The mean head at the turbines is 10.5 feet and the minimum head 9 feet. The hydraulic equipment consists of three Samson Leffel vertical turbines each of about 280 horse-power capacity, connected by crown gears to one horizontal shaft. Two horizontal generators, one of 250 K.W. and the other of 150 K.W. capacity are belted to this shaft. These generators are both 3-phase, 60-cycle, 600 revolutions per minute, 2,200-volt machines built by the Canadian General Electric Company. Three 250-K.V.A., station transformers step up the voltage from 2,200 volts to 26,400 volts, for transmission over the lines of the Rideau System.

This plant, which has recently been entirely overhauled and readjusted, has a capacity of approximately 535 electrical horse-power at 80% power factor in accordance with the rating of the Hydro-Electric Power Commission of Ontario.

(c) Storage Reservoirs.

At Cross, Gull, Long and Mazinaw Lakes, at the headwaters of the Mississippi, water storage of 2,620,000,000 cubic feet has been developed by the Mississippi Improvement Company, by means of rock filled, timber crib dams, and it is stated by the engineers of the Hydro-Electric Power Commission that this storage can be materially increased by further conservation works at Mud, Mississagagon, Kashwahamah, Buckshot and Grindstone Lakes. The storage is operated by the Mississippi Improvement Company, a private Company which was formed by the power site owners downstream, the expenses of operation being met by the power users, including the Commission.

(d) Merrickville Plant. - Rideau Power Company.

The only other generating station supplying power to the lines of the Rideau System is located on the Rideau River at Merrickville, and is owned and operated by the Rideau Power Company, Limited. This Company supplies power to the Rideau System under a ten-year contract. The generating station has an installed capacity of one 1,750 horse-power turbine coupled to a 562-K.V.A., 3-phase, 60-cycles, 600-volt generator. Serious power shortages have occurred at this plant for protracted periods due to the operation of the Rideau Canal. Power is delivered to the Rideau System from this plant through the transformer station at Merrickville, which has a capacity of 750 K.V.A., and steps up the voltage from 600 to 26,400 volts for transmission to the lines of the System.

(e) Undeveloped Power Sites, Rideau System.

On the Mississippi River about four miles upstream from the High Falls plant, commences a series of four rapids known respectively as Ragged Chutes, 39 feet head; Island Rapids, 38 feet head; Otter Rapids, 15 feet head; and King Rapids, 24 feet head. These four rapids aggregate about 116 feet total head, and reconnaissance surveys made by the Hydro-Electric Power Commission indicate that an economical development may be made by taking in at least seventy-seven feet and possibly the whole available head. Such a development would be somewhat similar to that at High Falls and would have the benefit of the same storage. A plant of 3,000 to 4,000 horse-power might possibly be installed at this site if the storage said to be possible be fully utilized, and the local constructional conditions prove feasible and economical, upon further investigation.

The drainage area above this site is about 450 square miles, the minimum precipitation is said to be 31.5 inches, and the average 35 inches per annum. The minimum monthly run-off of the river is given as 96 cubic feet per second with a yearly average of 513 cubic feet per second. These figures are based on precipitation records from 1915 and on gaugings from the year 1919.

(f) Miscellaneous Power Plants in the District.

There are ten small power plants within the boundaries of the territory included in the Rideau System, besides the two owned by the Hydro-Electric

Power Commission of Ontario. Of the ten, one is owned by an industrial company to develop energy for its own requirements and the other plants were originally developed to serve as public utilities. At the present time, the Rideau Power Company, Limited, Merrickville, and the two plants in the municipality of Almonte are the only ones generating power for public consumption, besides those of the Hydro-Electric Power Commission. The remaining plants are idle, but are available for emergencies.

The following table gives the location, size and ownership of the various plants in the district:

Table of Miscellaneous Power Plants in the District of the Rideau System

Location	Kind of Power	Approximate H.P.	River	Owner and Remarks
Almonte	Water	360	Mississippi	Municipal. Operate in parallel at 60-cycles.
Almonte (Wylie)	Water	200	Mississippi	
Kemptville	Water	300	Rideau	Kemptville Milling Company.
Merrickville	Water	750	Rideau	Rideau Power Co., (Insufficient water supply).
Perth (Glen Tay)	Water	175	Tay	Municipal, 60-cycles.
Perth (Badour)	Water	250	Tay	Municipal, 60-cycles.
Perth (Upper)	Water	125	Tay	Municipal, 133-cycles, (Usable for street lighting only).
Perth	Steam	250	-	Municipal, 133-cycles (discarded)
Smith's Falls	Water	300	Rideau Canal	Municipal, (60-cycles) combined hydro-electric and steam plant.
(Citizens Electric Plant)	Steam	84		
Smith's Falls	Water	600	Rideau	Municipal, (60-cycles) combined hydro-electric and steam plant.
(Smith's Falls Electric)	Steam	350		

The "Badour" and "Glen Tay" plants at Perth have both been remodelled recently and are now available as emergency generating stations or to be operated

in parallel with other plants on the Rideau System, should the demand for power warrant it. A 200-K.W., 3-phase, 60-cycle, 2,200-volt generator has been purchased and installed in each.

Transmission Lines.

Up to October 31st, 1922, the Hydro-Electric Power Commission of Ontario had constructed a total of 76.65 miles of high voltage transmission lines, forming a 26,400-volt network supplying the various municipalities. One district is supplied by means of a 2,300-volt line from the Balderson distributing station, a distance of 4.77 miles.

The transmission system is constructed on wooden poles throughout and presents no extraordinary features.

Transforming and Distributing Stations.

The transmission lines feed the various municipalities at low voltage through five substations, which are listed in the table on the following page, showing their voltage and capacity. Each of these stations supplies only one municipality, with the exception of that at Balderson. This station supplies Lanark as well as the village of Balderson.

In view of the fact that no power is developed by the St. Lawrence System and there is and may be a surplus of energy available from the Rideau System, and also because power may be purchased in quantity on the St. Lawrence System, provision has been made for the future inter-connection of these systems. The distributing equipment of the five stations of the Rideau System has all been

designed to change the transmission of power from 26,400 volts as at present to 44,000 volts, being the voltage of the receiving stations of the St. Lawrence System.

Table of Transforming and Distributing Stations

Location	Capacity K.V.A.	Voltage H.V.	Voltage L.V.	Remarks
Balderson	50	26,400	2,400	Feeds Lanark also at 2300 volts.
Carleton Place	750	26,400	2,200	
Kemptville	150	25,400	4,160	
Perth	500	26,400	2,300	
Smith's Falls	750	25,400	2,400	

Local Distributing Systems.

There are no municipalities on the Rideau System in which the Hydro-Electric Power Commission of Ontario distributes retail power to the consumers. The Commission acts as a wholesale distributor only and in all the municipalities the electricity is distributed by the municipality itself or by local commissions in the municipalities. It is understood that the accounting for all of the municipalities of the Rideau System is done in accordance with the standard accounting system of the Hydro-Electric Power Commission of Ontario, and the details for the various municipalities are given in the Annual Reports.

Characteristics of Market.

Population Served and Percentage of Consumers to Population.

The district served by the Rideau System is urban only, there being no rural lines built to October 31st, 1922. The bulk of the load is carried by the various municipalities. Two of these are small, having populations of less than 1,000 each.

"Municipal Statistics" of the Province of Ontario for 1921 gives a total population of about 50,000 for those portions of the Counties of Lanark, Grenville, Leeds, Frontenac, Renfrew, and Carleton, which are tributaries to the Rideau System. At October 31st, 1921, the total population in the four municipalities served by the system was about 14,500 persons, with about 3,200 consumers. As most of the towns tributary to the Rideau System are already supplied either by the Commission or by municipally owned plants or by privately owned plants, the greater part of the remainder can only be supplied by a fairly extensive system of rural lines. The four municipalities now served were billed with about 2,182 horse-power in 1921. During the first ten months of the fiscal year 1922 the power billed, including the added municipalities of Balderson and Kemptville, was about 2,118 horse-power. This also includes the power supplied to the Grenville Rock Company during the last six months of the fiscal year. The billed power for 1923 will probably increase by 500 horse-power or more, made up largely of the load of the Grenville Rock Company. This Company, it is understood, commenced to take power about April, 1922. The contract contemplates that

650 horse-power will be used, with possible additions in future. The normal growth of the system will doubtless require several hundred horse-power as well.

The following table gives in detail the number of consumers at the end of the fiscal year 1921 in the places served by the Commission, the approximate horse-power billed to each place in 1921, and the average horse-power per consumer in 1921. The figures are useful for comparison with other systems, although they should be used with caution. No figures for kilowatt-hours consumed are available.

Table of Market Statistics

Consumer	Population	Number of Consumers	Percentage Consumers to Population	H. P. Billed in 1921	H. P. Billed per Consumer
Carleton Place	3,430	827	24.1	730.0	0.88
Lanark	625	107	17.1	3.2	0.03
Perth	3,630	803	22.1	524.1	0.65
Smith's Falls	6,665	1,431	21.5	874.4	0.61
Totals	14,350	3,168	22.5	2,131.7	

The average horse-power billed per consumer in 1921 was 0.67, and the average horse-power billed per capita was 0.15, while the average ratio of consumers to population served is 22.5%.

Growth of Market and Ultimate Sources of Power Supply.

Since the commencement of operations of the Rideau System in September,

1918, the growth has been fairly steady except for a decrease of about 260 horse-power during 1921. The loads for the System are as follows, the figures being given in horse-power for the month of October in each year: 1918, 414; 1919, 1,306; 1920, 2,304; 1921, 2,043.5. These figures are the sum of the loads in October for the various municipalities, and do not show the actual peaks on the System, but they do indicate the growth of the demand.

The ultimate source of power supply for the Rideau System when all the available local plants will have been used to full capacity, or else discarded, is undoubtedly transmitted power from large plants contemplated at Carillon, Chats Falls and Bryson on the Ottawa River, or at the Chelsea and the Paugan sites on the Gatineau River, where large amounts of power aggregating several hundred thousand horse-power can be made available. The proposed development of the St. Lawrence River powers could doubtless provide all of the power necessary for the Rideau System, but it would probably be more economical to use the Ottawa and Gatineau River sites.

If the Rideau System and the Ottawa System be extended southwards and eastwards, and the St. Lawrence System be extended northwards, it is possible that in the future inter-connecting lines may be constructed so that any of these systems might receive power either from the water powers on the St. Lawrence River or from the Ottawa and Gatineau Rivers.

The present indications are that the actual total amount of power required for the Rideau System will not reach the capacity of the various local generating stations and sites within the System for some years to come.

The problem of serving rural customers is difficult, as the average number of consumers per mile is small, the experience of the Hydro-Electric

Power Commission being that only three or four per mile on the average are obtainable.

The situation at the present time is that there is a shortage of power at High Falls and Merrickville, and that some of the small plants elsewhere have had to be put into service to supply the recent demand for power. The demands will undoubtedly increase and it is understood that applications are already before the Commission for a considerable mileage of new lines to serve rural districts. There are many small places in the district which do not yet receive power from the Rideau System.

In certain centres, for example, at Almonte and Merrickville, the people are apparently satisfied to continue under their present private arrangements. From the table of miscellaneous plants shown on page 17, and from the fact that large new privately-owned power developments are contemplated within easy transmission distance, it is evident that a large capacity of private power plants could be made available to serve the whole of the easterly portion of Ontario in competition with the Hydro-Electric Power Commission of Ontario. Alternatively, it is possible that some of these plants would consider selling large blocks of power to the Commission under wholesale conditions and allow the Commission to do the distribution without competition.

Capital Costs.

General.

The figures of capital costs given in the following table, and plotted

diagrammatically, and shown on the sheet of curves included as page 25, were obtained from page 7 of the report on the accounts of the Rideau System by Messrs. Price, Waterhouse & Co., to the Hydro-Electric Inquiry Commission under date of November 7th, 1922.

Table of Progressive Capital Costs

Capital Assets	Fiscal Year Ending October 31st, 1918	1919	1920	1921
Power Development	$ 30,955	$430,515	$ 748,941	$ 756,285
Transmission Lines	103,469	218,717	233,602	260,654
Transforming and Distributing Stations	17,174	32,234	49,844	57,065
Totals	$151,598	$681,466	$1,032,387	$1,074,004

It will be noted that the total capital costs to the end of 1921, amounting to approximately one million and seventy-four thousand dollars, is divisible roughly into six hundred and ninety-five thousand five hundred dollars for the plant at High Falls, sixty-one thousand dollars for the plant at Carleton Place, two hundred and sixty-one thousand dollars for transmission lines, and fifty-seven thousand dollars for transforming and distributing stations.

It might be of interest to note that the estimated cost of the development was placed at $340,000 by the Commission in its application dated June 25th, 1918, to the Prime Minister of Ontario, asking for authority to construct. This amount

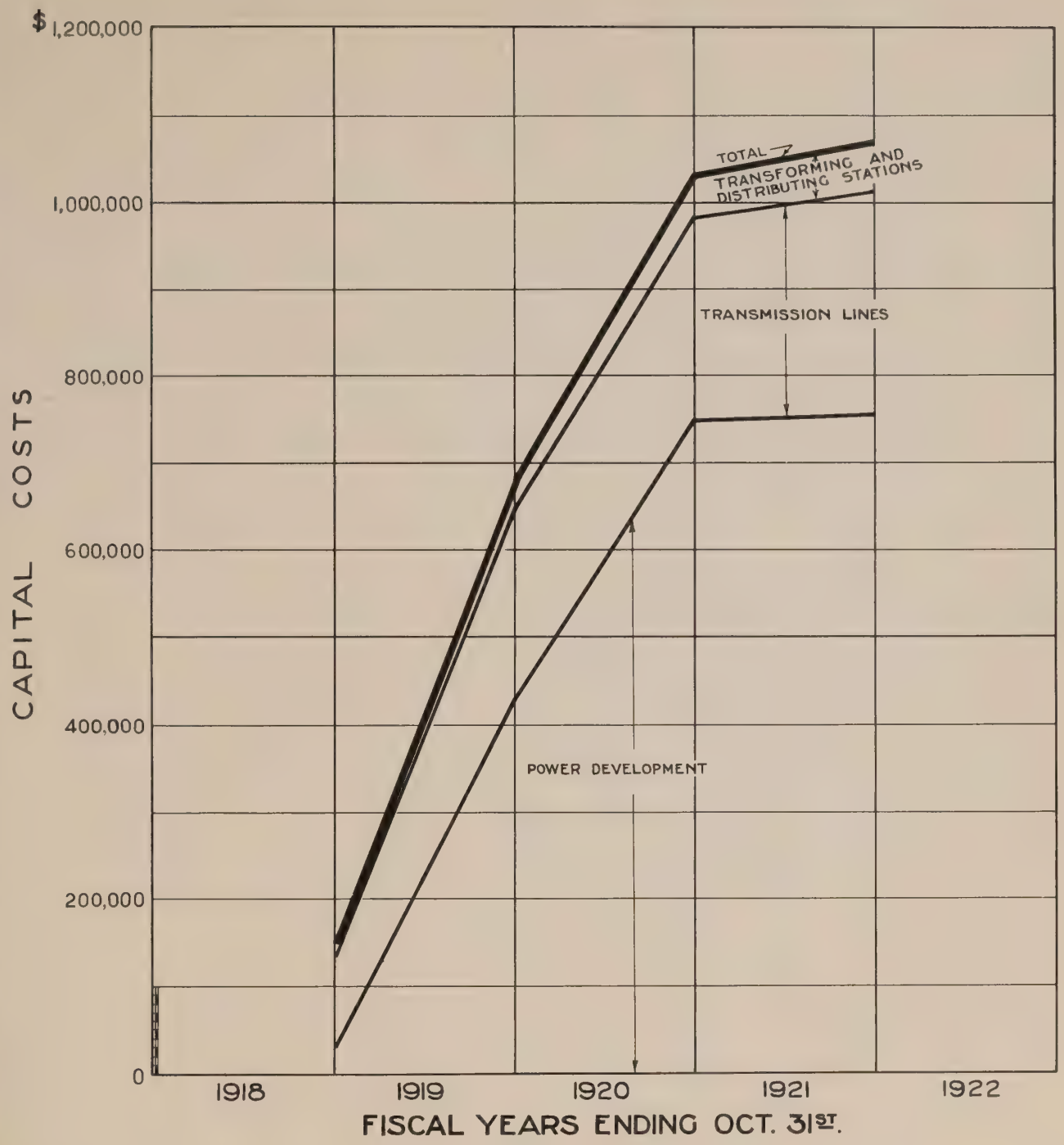
Hammermillville, and Rouse as the plant of various industries on pages 16, mentioned from page 7 of the report as the headquarters of the Thomas Jones Company, Thomas-Jones & Co., or the Cyclo-Chemicals Supply Company under date of December 7th, 1920.

Sales of Principles Special Steels

Special Steels	Year	Year	Year	Year	1923
Power Specialtyweed	$ 91,110	$420,215	$ 790,963	$	781,483
Transmission Lines	149,629	314,717	322,802		190,414
Transformers and Sig-nalizing Stations	37,174	16,374	62,964		97,482
Total	$[illegible]	$801,404	$1,202,827	$1,[illegible]	

It will be noted that the total capital costs in the year of 1921, amounting to approximately one million and seventy-four thousand dollars, is slightly less than six quarters and seventy-four thousand dollars. For the plant as it was built, slightly-one thousand dollars for the plant of Carlisle Tower, ten thousand and eighty-one thousand dollars for transmission lines, and 37,174-seven-thousand dollars for transformers and signalizing stations.

It might be of interest to note that the maximum work of the Corporation was placed at Cincinnati by the Commission in its negotiations with the City, after in the Prime Minister of Canada, during the negotiations in Washington.



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
RIDEAU SYSTEM

PROGRESSIVE CAPITAL COSTS

Toronto, Mar. 24th., 1923. Made by W.D. Checked by L.H.
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was to include the cost of constructing 22 miles of transmission lines from High Falls to Perth, as well as the plant of 3,000 horse-power at High Falls. The subdivision of the total actual capital costs of the High Falls plant is as follows: land and water rights, $10,478; dams and water structures, $279,507; power house, $240,758; equipment, $164,711; intangibles, none; total, $695,414. The Carleton Place plant subdivision is as follows; land and water rights, $10,275; dams and water structures, $12,450; power house, $20,682; equipment, $17,464; intangibles, none; total, $60,871. These figures do not include anything for transmission lines.

The large additions to the costs for transmission lines, and transforming and distributing stations from year to year is due to the fact that the System, first started at the end of September, 1918, has been extended each year, additional municipalities being put on the System and served by new transmission lines and distributing stations. In 1921 additions were made to certain equipment of the High Falls generating station, and spare generator coils were also provided.

It has been estimated that additional funds of $100,000 will be required during 1922, and $20,000 during 1923 in order to complete extensions and improvements at High Falls and other stations, together with expenditures on account of rural distribution in townships already under application to the Rideau System of the Hydro-Electric Power Commission of Ontario. The cost of the proposed storage improvements is apparently not included in these estimates, as this work would probably be done by the Mississippi Improvement Company.

If these expenditures be made, the total capital investment at October, 1923, will be about $1,200,000.00.

Power Data.

The following table and the diagram on page 28 have been prepared to show the characteristics of the Rideau System in terms of horse-power:

Table of Horse-power Developed, Billed, Etc.

	Fiscal Year Ending October 31st, 1919	1920	1921	1922
H.P.Developed	535	3 335	3,335	3,335
H.P.Purchased	669	479	363	398
H.P.Developed plus Purchased	1,204	3,814	3,698	3,733
H.P.Billed	830.8	1,637.5	2,131.7	* 2,117.9
H.P.Average of 12 Monthly Peaks	835	1,880	2,092	2,479
H.P.Maximum Yearly Peak	1,404	2,480	2,627	3,183

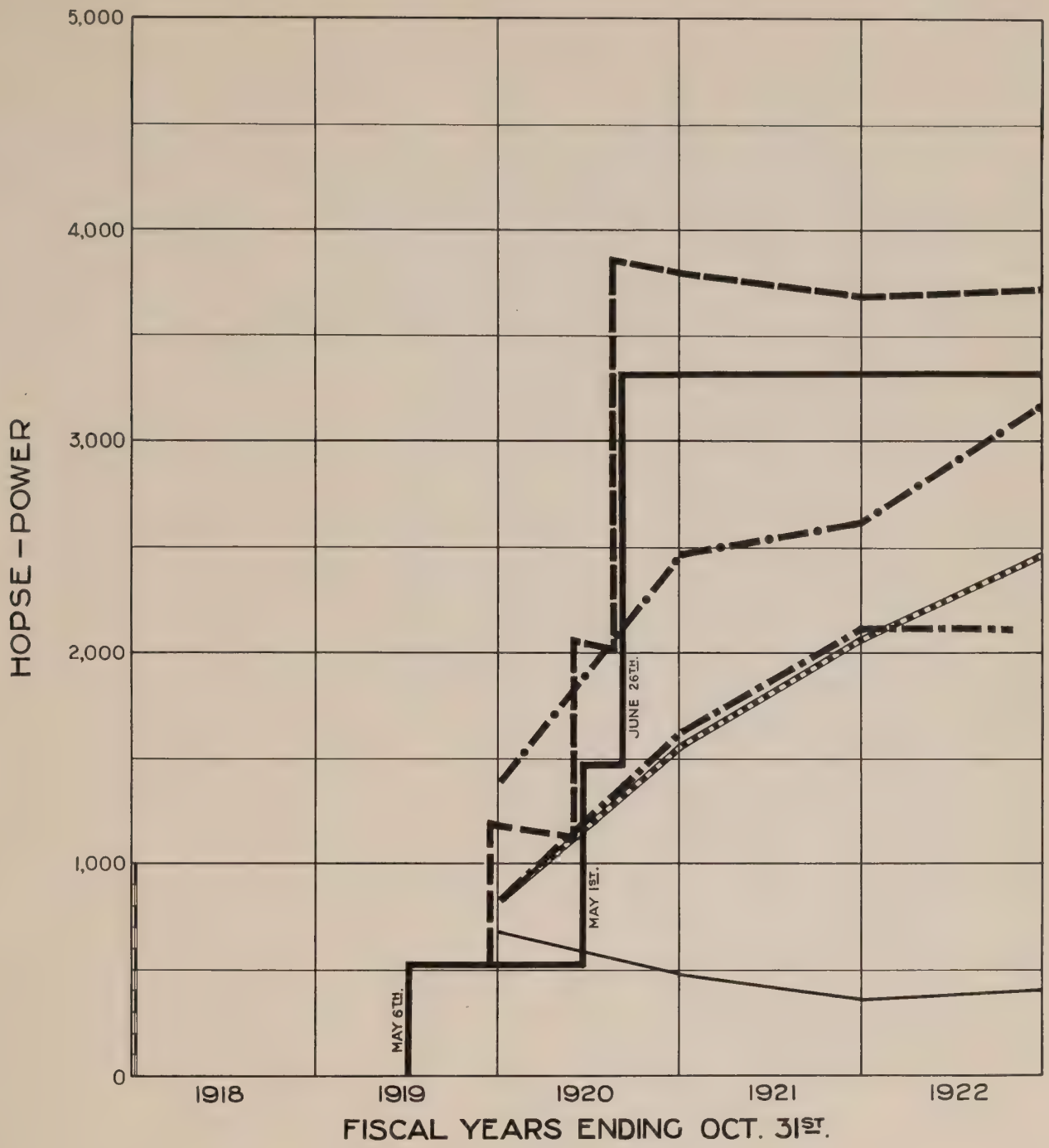
* For ten months only, ending August 31st.

Although operation of the Rideau System commenced at the end of September 1918, when Smith's Falls first took a supply of power from the Merrickville station, no figures have been included for the month of October, 1918, in the table of horse-power data shown above.

It will be noted that there are six different classes of horse-power shown in the table and on the diagram. These may be explained as follows:

Developed Horse-power.

The figures for plotting the curve showing developed horse-power were



H. P. DEVELOPED
" " PURCHASED
" " DEVELOPED PLUS PURCHASED
" " BILLED
" " AVERAGE OF 12 MONTHLY PEAKS
" " MAXIMUM YEARLY PEAKS

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RIDEAU SYSTEM

HORSE-POWER DATA

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obtained from the records of the Hydro-Electric Power Commission of Ontario, and are the sum of the capacities of the Carleton Place station and the various units installed in the High Falls generating station expressed in horse-power at 80 per cent. power factor according to the usual Hydro-Electric Power Commission rating.

Purchased Horse-power.

The figures for the curve showing the horse-power purchased were obtained from the table on page 11 in the report of Price, Waterhouse & Co. on the "Investigation of the Accounts of the Rideau System" dated November 7th, 1922, Hydro-Electric Inquiry Commission file 197-a, dated November 14th, 1922, and are the average values of horse-power purchased by the Rideau System from the Rideau Power Company, Limited, at Merrickville.

Developed plus Purchased Horse-power.

The figures for the curve showing developed plus purchased horse-power were obtained by adding together the two first lines of the table on page 27.

Billed Horse-power.

The curve of total horse-power billed was plotted from data given in Exhibit I-A, in the report of Price, Waterhouse & Co. already referred to, and is the amount charged to consumers on the system.

Average Monthly Peaks.

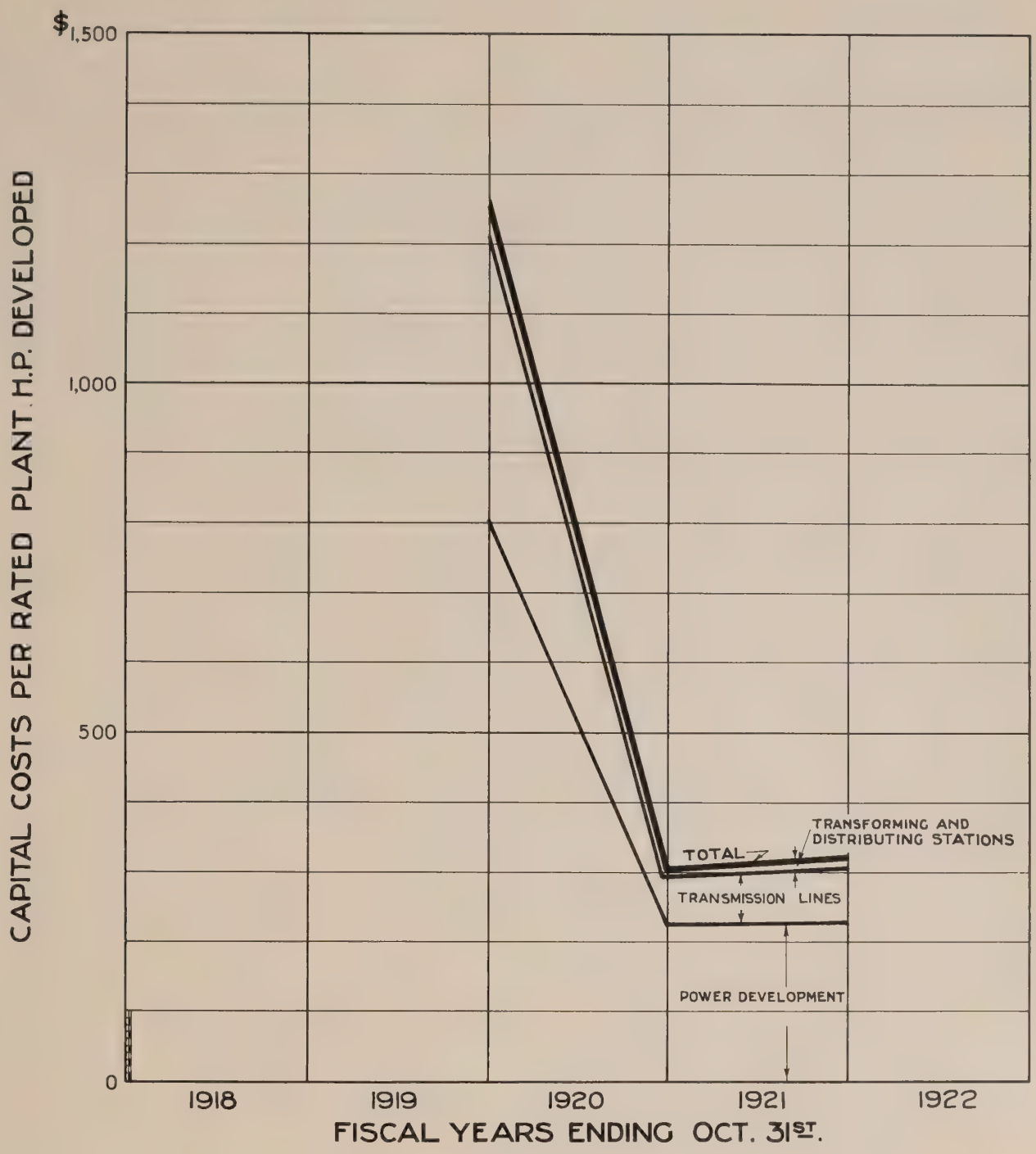
The curve of average monthly peaks was obtained by taking the average of the twelve monthly maximum peaks for each year as shown in the records of the Hydro-Electric Power Commission of Ontario, and dividing the sum of the monthly peaks by 12 to get a yearly average monthly peak. Each of these averages was then plotted as a single point for the average monthly peak of each year.

Maximum Yearly Peaks.

The curve showing the maximum yearly peaks was plotted directly from the maximum peak indicated for each year from the same source as used for the derivation of the curve of average monthly peaks.

Capital Costs per Horse-power Developed.

The diagram included as page 31 and the following table indicate the fractional capital costs per rated plant horse-power developed, at different points of delivery, based on the figures showing the capital costs of the System, and the horse-power data given on page 27. This sheet of curves, therefore, indicates the capital costs per rated plant horse-power with the spaces between adjacent curves indicating that portion of the total (delivered) capital costs per horse-power chargeable against each of the items of the table, as follows:



HYDRO-ELECTRIC INQUIRY COMMISSION
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RIDEAU SYSTEM
CAPITAL COSTS
PER HORSE-POWER DEVELOPED
Toronto, Mar. 24th., 1923. Made by V.C.D. Checked by L.L.
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Table of Capital Costs per Rated Plant Horse-power Developed

	1919	1920	1921
Power Developed	$ 804.70	$224.87	$226.77
Transmission Lines	408.82	70.05	78.76
Transforming and Distributing Stations	60.25	14.94	17.11
Totals	$1,273.77	$309.86	$322.64

It will be seen from this table that the capital costs per rated plant horse-power developed are very high for 1919. This is due to the fact that expenditures for the High Falls development are included therein, while no power had yet been made available there.

For purposes of comparison the following table of capital costs per rated plant horse-power developed plus power purchased has been included. From this it may be seen that capital costs per horse-power developed plus purchased for the year 1919 is less than half that per horse-power developed during the same period, while a smaller decrease in capital costs per rated horse-power developed plus purchased is also shown for the years 1920 and 1921.

Table of Capital Costs per Rated Plant Horse-power Developed plus Purchased

	Fiscal Years Ending October 31st, 1919	1920	1921
Power Development	$367.50	$196.30	$204.50
Transmission Lines	181.70	61.30	70.40
Transforming and Distributing Stations	26.80	13.10	15.50
Totals	$566.00	$270.70	$290.40

Total Revenues.

The table below, giving the total revenues of the Rideau System, has been prepared by using the figures of Exhibit I, supplemented from page 9 of the report on "Investigation of Accounts of Rideau System", dated November 7th, 1922, Hydro-Electric Inquiry Commission file No. 197-a. The sheet of curves on page 34 shows the revenues in graphic form.

The municipalities were charged with the cost of power and the distribution thereof and with that portion of the fixed charges which pertained to the power supply. The table of revenues is as follows:

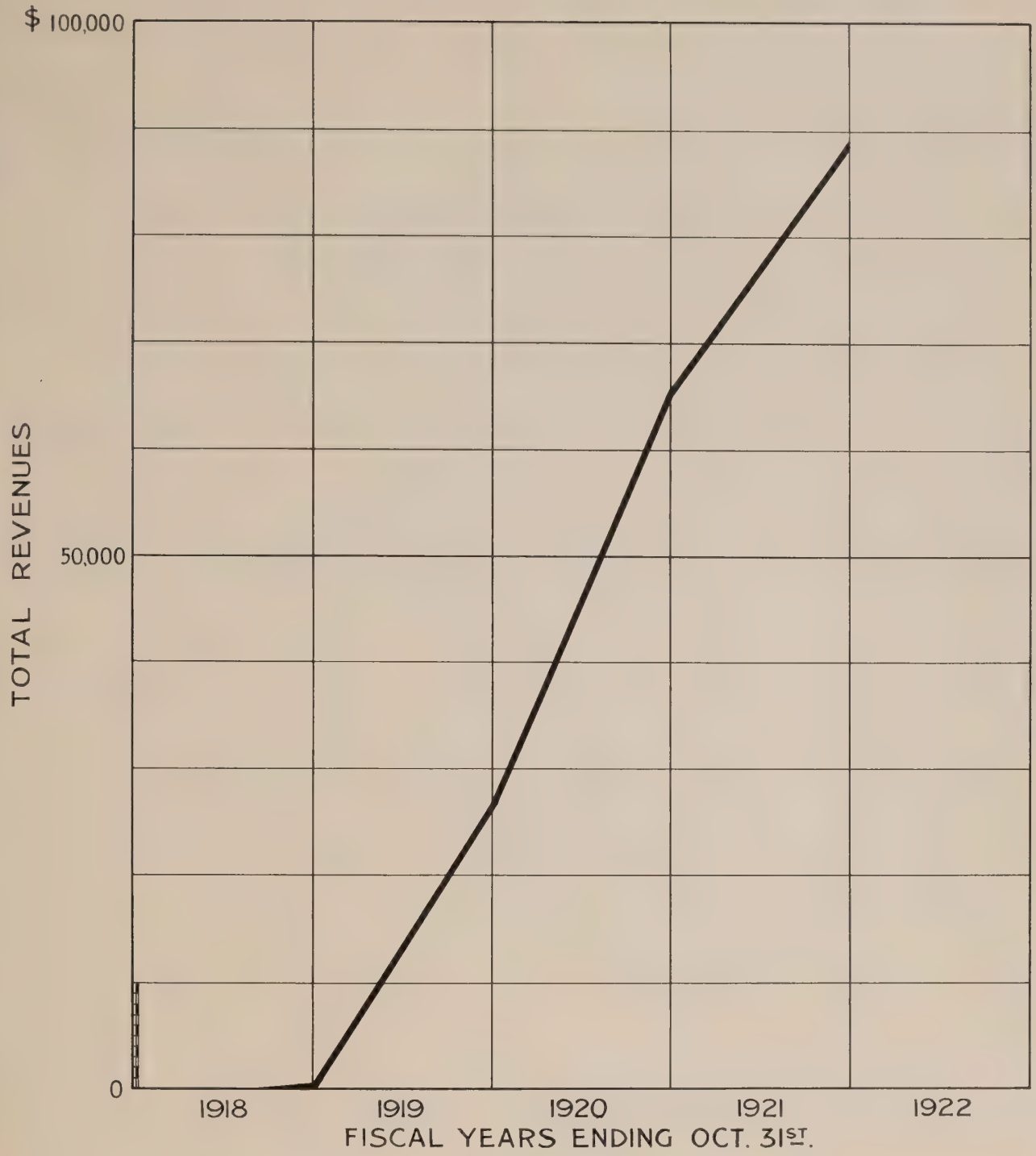
Table of Annual Revenues

Period	Total Revenues per Annum
Year Ending October 31st,	
1918	$ 494.00
1919	27,351.00
1920	65,523.00
1921	89,014.00

Total Costs of Power.

The table on page 36 shows the cost of power subdivided under various headings for the years 1913 to 1921 inclusive. These are made up from Exhibit I of the Price, Waterhouse & Co. report dated November 7th, 1922.

The headings under which the various costs have been grouped are as follows:



HYDRO-ELECTRIC INQUIRY COMMISSION
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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
RIDEAU SYSTEM

TOTAL ANNUAL REVENUES

Toronto, Mar. 24th., 1923. Made by S.R.W., Checked by L.L.H.
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Power Purchased.

A separate heading for power purchased has been included for the reason that there was no power generated on this System by the Commission to any great extent until the year 1920, the power purchased having supplied the greater portion of the load on the System up to that year.

Operating Costs.

Operating costs include the wages of power house operators, linemen, station attendants and so forth, supplies and all miscellaneous items usually grouped under this heading.

Maintenance.

Under maintenance have been placed all the items for labour and materials charged in the books of the Commission as against the individual portions of the plant, stations, lines and distributing stations, and these have been grouped together from the individual figures of the Price, Waterhouse & Co. report to make one item.

Overhead and General Expense.

Under the heading of overhead and general expense are such items as salaries of local officers and clerks, printing and stationery, stores operation, taxes, insurance, rents, legal expense, miscellaneous office supplies and so forth, all in accordance with the Price, Waterhouse & Co. report.

Interest, Renewals, Sinking Fund and Contingencies.

The figures for interest include all interest charges shown for the capital invested in the System. The renewal account includes all items shown as chargeable against renewals in the same report, while the figures for sinking fund and contingencies have been transferred directly from the report.

The sheet of curves on page 37 is the direct plotting of the figures in the table below, with the spaces between adjacent curves indicating the amount chargeable against that particular item. The figures are as follows:

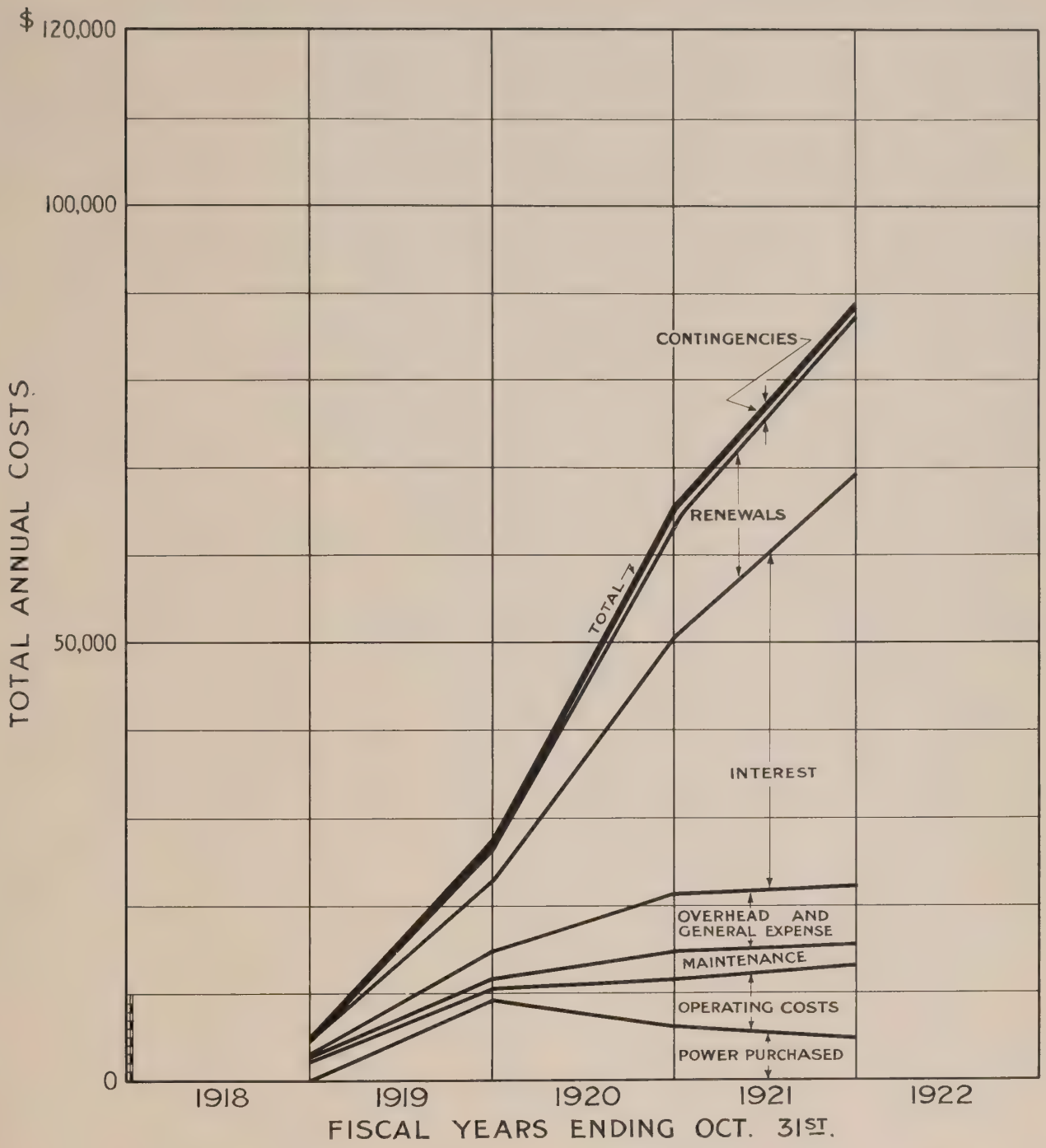
COPY

Table of Total Annual Costs of Power

	Month of October 1918	Fiscal Years Ending October 31st, 1919	1920	1921
Power purchased	-	$ 9,366	$ 6,705	$ 5,077
Operating	$211	1,382	5,074	8,368
Maintenance	64	859	3,132	2,511
Overhead and General Expense	38	3,202	6,830	6,111
Interest	181	8,119	29,368	47,216
Renewals	-	4,215	14,505	19,198
Sinking Fund	-	-	-	-
Contingencies	-	208	409	533
Totals	$494	$27,351	$65,523	$89,014

Percentage Costs of Power.

The following table and the sheet of curves included as page 38 show the



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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
RIDEAU SYSTEM
TOTAL ANNUAL COSTS
Toronto, Mar. 24th, 1923. Made by S.R.W. Checked by C.L.H.
WALTER J. FRANCIS & COMPANY
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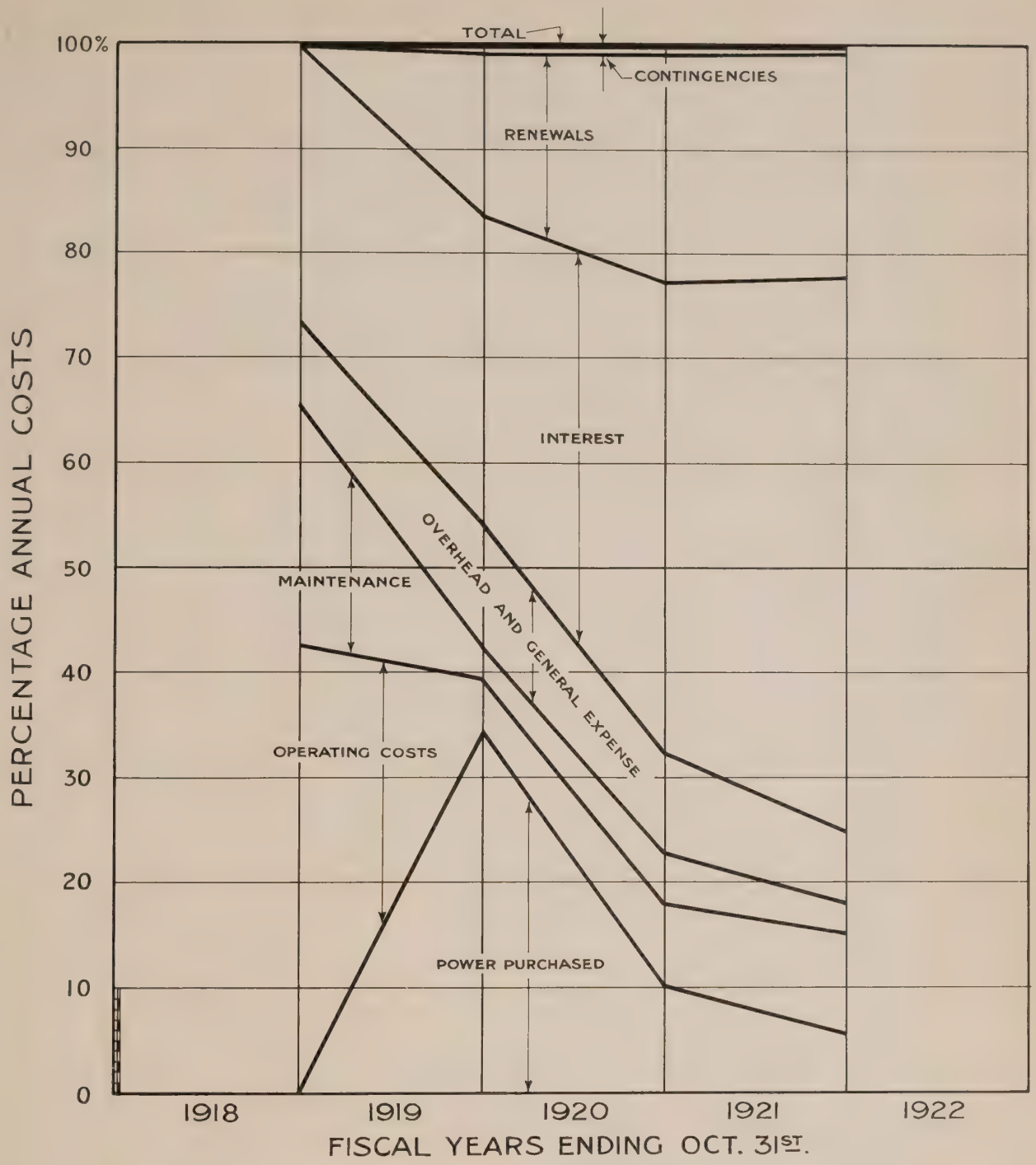

HYDRO-ELECTRIC INQUIRY COMMISSION
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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

RIDEAU SYSTEM

ANNUAL COSTS SUBDIVIDED BY PERCENTAGES

Toronto Mar. 24th., 1923. Made by S.R.W., Checked by L.A.H.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

cost figures as percentages of the total cost of power per annum, and these are included as a method of comparison with other systems or similar properties:

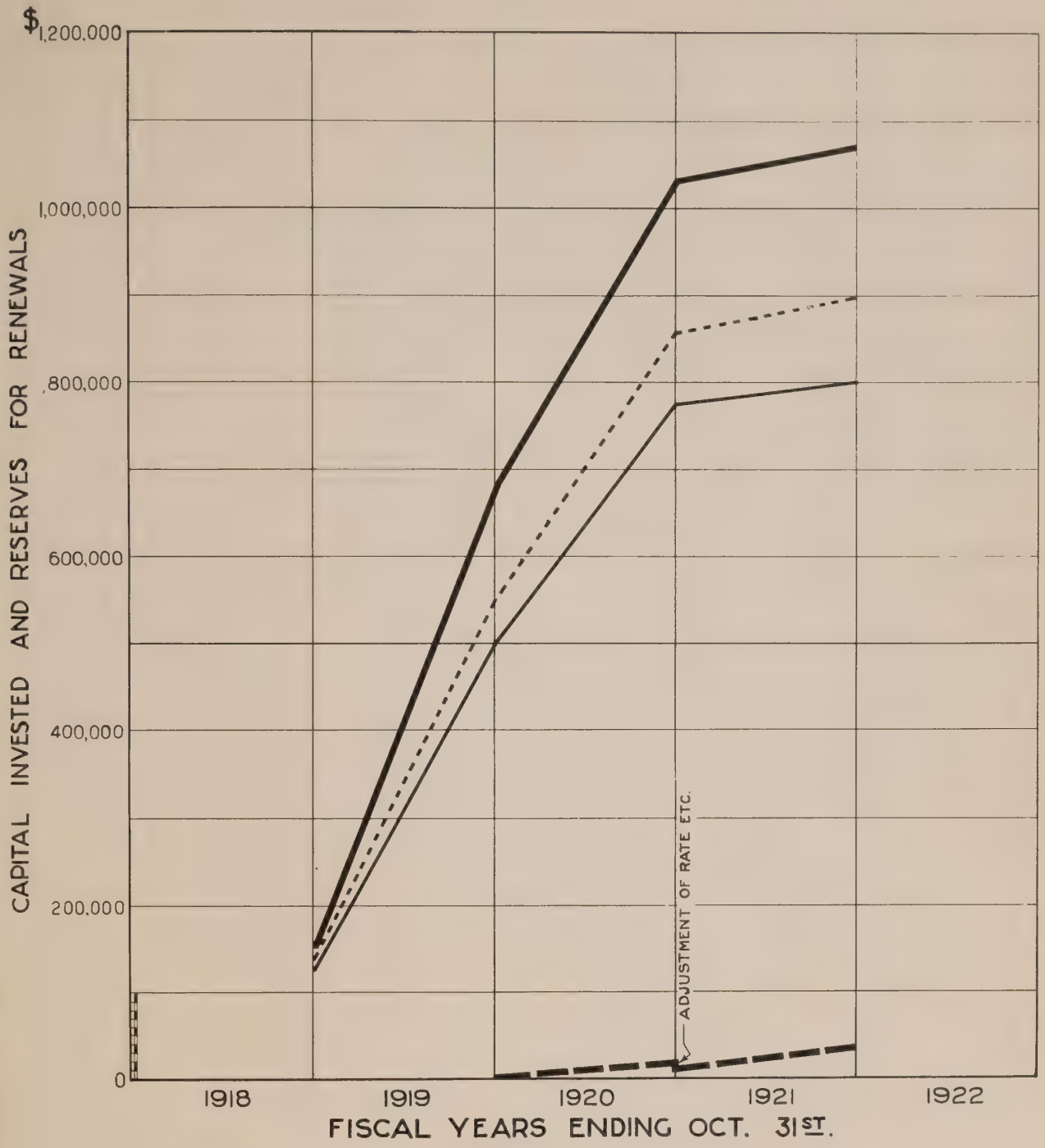
Table of Annual Costs Subdivided by Percentages

	Month of October 1918	Fiscal Years Ending Oct. 31st, 1919	1920	1921
Power Purchased	-	34.30	10.22	5.72
Operating	42.72	5.06	7.75	9.41
Maintenance	12.94	2.14	4.78	2.82
Overhead and General Expense	7.69	11.70	9.65	8.07
Interest	36.65	29.63	44.80	53.02
Renewals		15.40	22.17	21.55
Contingencies		0.77	0.62	.60
Total	100.0%	100.0%	100.0%	100.0%

Analysis of Reserve Accounts.

Renewals Account.

The following table and the sheet of curves included as page 40 show the amounts set aside as reserve for renewals as they exist at the present time on the books of the Hydro-Electric Power Commission. As stated on page 11 in the report of Price, Waterhouse & Co., the balance in the reserve for renewals of the Rideau System amounted to $38,865.47 at October 31st, 1921, after giving effect to the adjustment discussed below, and may be briefly summarized as



TOTAL INVESTED CAPITAL
APPROXIMATE DEPRECIABLE CAPITAL
APPROXIMATE DEPRECIABLE CAPITAL LESS RESIDUAL VALUES
RESERVE FOR RENEWALS

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

RIDEAU SYSTEM

RESERVES FOR RENEWALS

Toronto, Mar. 24th, 1923. Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

follows:

Table of Reserve for Renewals

Fiscal Year	Reserve on 2.25% Basis Net	Interest	Total	Reserve on 1.85% Basis Net	Interest	Total	Amount of Adjustment Net	Interest	Total
1918 1919	$4.215	-	$ 4,215	$3,466	-	$ 3,466	$ 749	-	$ 749
1920	14,506	$169	14,675	11,927	$139	12,066	2,579	$30	2,609
	$18,721	$169	$18,890	$15,393	$139	$15,532	$3,328	$30	$3,358
1921				19,198	621	19,819			
Together				$34,591	$760	$35,351			
Reserve applicable to equipment transferred to system				2,968	155	3,123			
Together				$37,559	$915	$38,474			
Deduct Sundry Charges						108			
Total at October 31st, 1921						$38,366			

During the period from the commencement of operations to October 31st, 1920, the additions to the reserve for renewals in respect of the properties of the System, were provided through inclusion, in the cost of power to the municipalities, of an annual charge of 2.25% on the capital investment. Interest at the rate of 4 per cent. per annum on the balance on the reserve account is credited to that account.

On the recommendation of its engineers, the Commission, commencing in the fiscal year 1921, reduced the annual renewal rate from 2.25% to 1.85% on the total capital investment, while the interest rate of 4 per cent. remained

unchanged. The accounts of the Commission were so adjusted that the rate of 1.85% was made effective from 1918 to October 31st, 1920, and the same renewal rate has obtained to October 31st, 1921.

The reduction in the renewal rate, made effective in the fiscal year 1921, was determined by a reclassification of the properties, as reflected in the book accounts as at October 31st, 1920, made by the Engineering Department of the Commission. The 1921 rate, 1.846% was arrived at as follows: from the total capital expenditures as at October 31st, 1920, $173,524 was deducted, representing properties of a substantial nature for which no provisions for renewals were considered necessary, for example: reinforced concrete dams, lands, flowage, water rights and so forth. A residual value of $87,358.00 was estimated for all other properties, thus making a sum of $260,882.00 for which no reserve for renewals was necessary. An annual sum of $19,059.50 was calculated from the various useful life items, which sum represents 1.846% of the total invested capital at the end of 1920. A rate of 1.85% was adopted as a matter of convenience. It is stated in the report of Price, Waterhouse & Co. that clerical errors occurred in the computation of the Engineering Department, and the rate should have been 1.228% on the total capital invested instead of 1.846%, a difference of .618%. As a result of this arithmetical discrepancy, it is understood the Commission is now considering a further reduction in the annual renewal rate and a consequent adjustment of the entire Reserve for Renewals Account.

The sinking fund basis of making additions to the reserve account for renewals at the rate of 1.85%, together with interest at 4 per cent. per

annum, is equivalent to the so-called straight line provision of approximately 3-1/2 per cent. for a period of about twenty-nine years. While the annual provisions under the two methods differ in amount, either method would accumulate the sum required in approximately that period.

The amount of the adjustment made in 1921 for the period 1918 to October 31st, 1920, resulted in a decreased cost of power to the various municipalities amounting to $3,358.10, and this amount has been credited to the municipalities. Should the further contemplated retroactive reduction in the renewal rate be made, the cost of power to the municipalities would be correspondingly decreased for those years affected.

It is understood that it is the practice of the Hydro-Electric Power Commission to spend sufficient money on maintenance account each year so as to keep each and every portion of the System in a condition to operate in accordance with the requirements of economical production, which it is stated is considered to be about 75 per cent. as good as its original new condition. This being so, it was considered in this report that the renewal accounts should be studied in connection with and applied to the renewal of only 25 per cent. of the capital concerned.

Two questions should receive consideration in dealing with these reserves for renewals; one is the proposed change in the estimated useful length of life of the various portions of equipment which will materially affect the annual allowances, and the other is the proper rate of interest to be chosen in estimating the earning power of the invested reserve funds.

A strict theory of the earning power of the renewal fund would take into

consideration not only the method of investing the fund, for example, whether it be used in making extensions and betterments in the System as has actually been done, or invested in separate securities and treated like a trust fund; but also the rate of annual interest which should be adjusted each year in accordance with the actual value of the money. The legal limitations of the allowable investment of the fund should also be kept in mind in this connection.

At the present time the total depreciable capital is probably between $800,000 and $900,000, while the reserve for renewals to the end of 1921 was about $38,000, and should be about $57,000 at the end of 1922 assuming that the 1.85% rate was applied. As a large portion of the total depreciable capital has been invested within the past three years and as the various portions of the equipment have only been in service for a very brief period, it would therefore appear that the present total accumulations of the fund as applicable to 25 per cent. of the depreciable capital is somewhat larger than is necessary, taking all the above factors into consideration.

Sinking Fund.

In view of the fact that the Rideau System has not served any municipality with electrical energy for a period of five years, there have been, up to the present, no payments made to a sinking fund in accordance with the provisions of Section 23 of the Power Commission Act.

Reserve for Contingencies.

A study of the accounts of the System shows that up to the end of the

fiscal year 1921 a total reserve for contingencies had been set aside amounting to $1,183.31, made up of an annual charge of 25 cents per horse-power on the average power billed to the municipalities, and of accrued interest at 4 per cent. per annum for a period including the fiscal years 1919, 1920 and 1921 ending October 31st. This fund has not as yet been drawn on, due probably to the short time this System has been in operation.

Having in mind the heavy losses which might be occasioned through catastrophe, it is felt that the total amount at the credit of this fund, namely $1,183.31, should be augmented by increasing the annual allowance for contingencies, and when a reserve of, say, $15,000 or $20,000 will have been built up the rates can be readjusted to suit the conditions found after several further years of experience.

Discussion of Deficits and Surpluses.

The records show that the System as a whole has been billed with the cost of power in accordance with the book-keeping methods of the Hydro-Electric Power Commission of Ontario since 1919, and that there are now no deficits nor surpluses for the System as a whole. This does not take into account the local distribution in the various municipalities which is done by the municipality itself or by a separate commission in such municipality, and where the profits or losses are not included in the accounts of the Hydro-Electric Power Commission for the Rideau System.

Revenues and Costs per Horse-power per Annum.

In order to reduce the total revenues and total costs of operation to a basis where these would be comparable with other systems and to agree with the usual practice of similar companies and of distribution authorities, the table below has been prepared to show the revenue per horse-power per annum for different bases of horse-power. In a similar way the total costs have been reduced to costs per horse-power per annum for different bases of horse-power, and have also been analyzed to show the total annual costs subdivided into fractional amounts chargeable against each kind of expense, based on the horse-power rating of the plant and also on the average horse-power billed.

The following series of diagrams with the tables of figures for each show these various items in detail.

Revenues per Horse-power per Annum.

The revenues for each of the various classifications of horse-power are given in the table below:

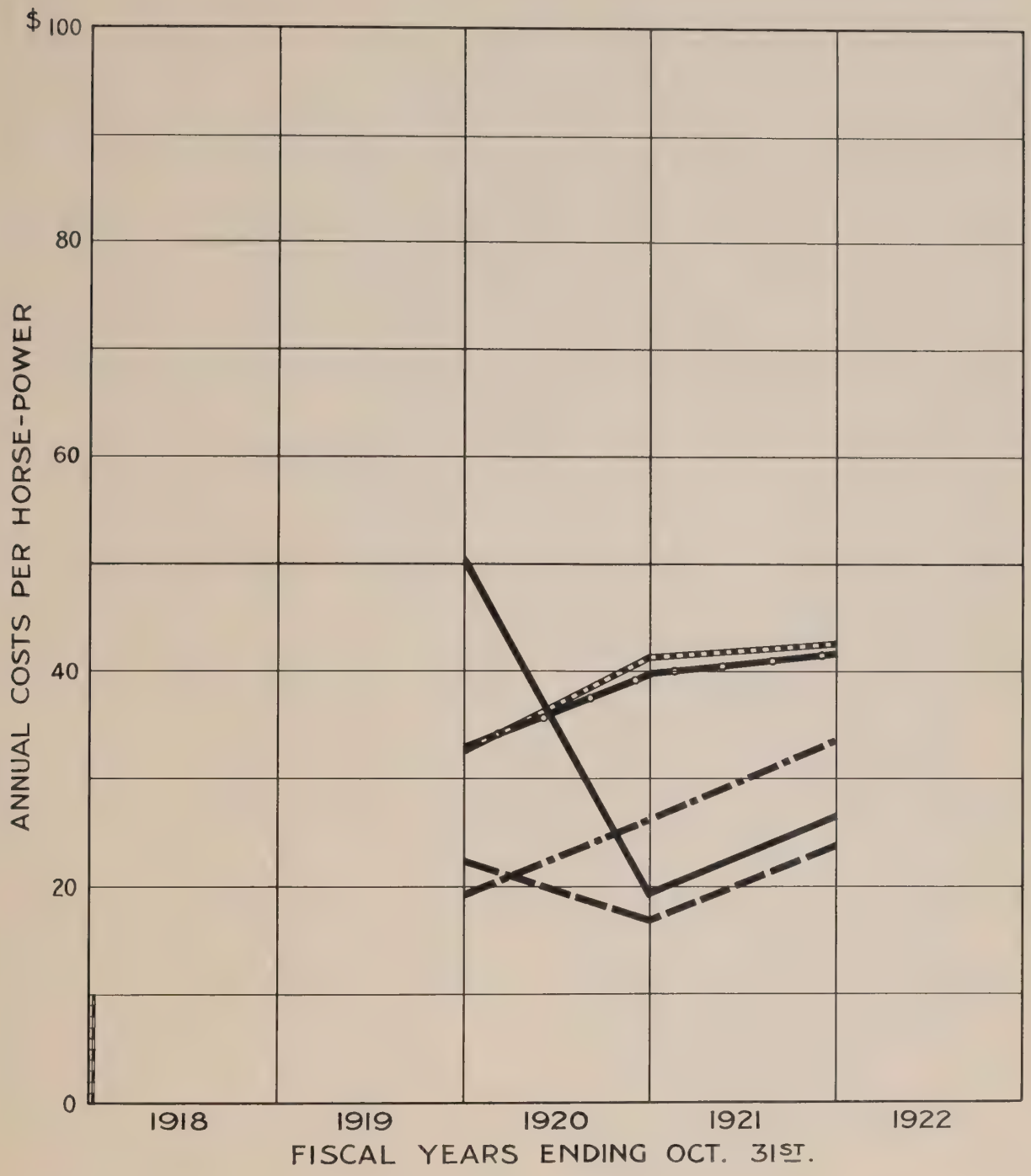
Table of Revenues per Horse-power Per Annum

	Fiscal Years Ending October 31st, 1919	1920	1921
H.P. Developed	$51.12	$19.65	$26.59
H.P. Developed plus Purchased	22.72	17.19	24.08
H.P. Billed	32.92	40.02	41.76
H.P. Average of 12 Monthly Peaks	32.75	41.50	42.60
H.P. Maximum Yearly Peak	19.50	26.45	33.90

Annual Costs per Horse-power.

The tables on pages 50 and 52 and the three sheets of curves included as pages 48, 49 and 51 show the details of the costs per horse-power per annum on different bases. The figures from which these curves were plotted are the figures for the operating costs given in the table on page 36 divided by figures for the various classes of horse-power already given in the text. The table on page 50 and the sheet of curves included as page 48 indicate the total costs per horse-power per annum for the different classifications of horse-power already discussed. It will be noted that the total costs per horse-power balance with the total revenues per horse-power for the whole term of operation of the System.

The sheet of curves on page 49 entitled "Subdivided Costs per Horse-power Developed" indicates the subdivision of the total annual costs as between power purchased, operating, maintenance, overhead and general expense, interest, renewals and contingencies, divided by the total amounts of horse-power developed in the High Falls and Carleton Place plants. For comparison a table is given showing the subdivided costs per horse-power developed plus purchased, but no curves have been plotted for this. Similarly, the table on page 52 and the sheet of curves on page 51 indicate the subdivided costs per horse-power billed.



H. P. DEVELOPED
H. P. DEVELOPED PLUS PURCHASED
H. P. BILLED
H. P., AVERAGE OF 12 MONTHLY PEAKS
H. P., MAXIMUM YEARLY PEAK

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

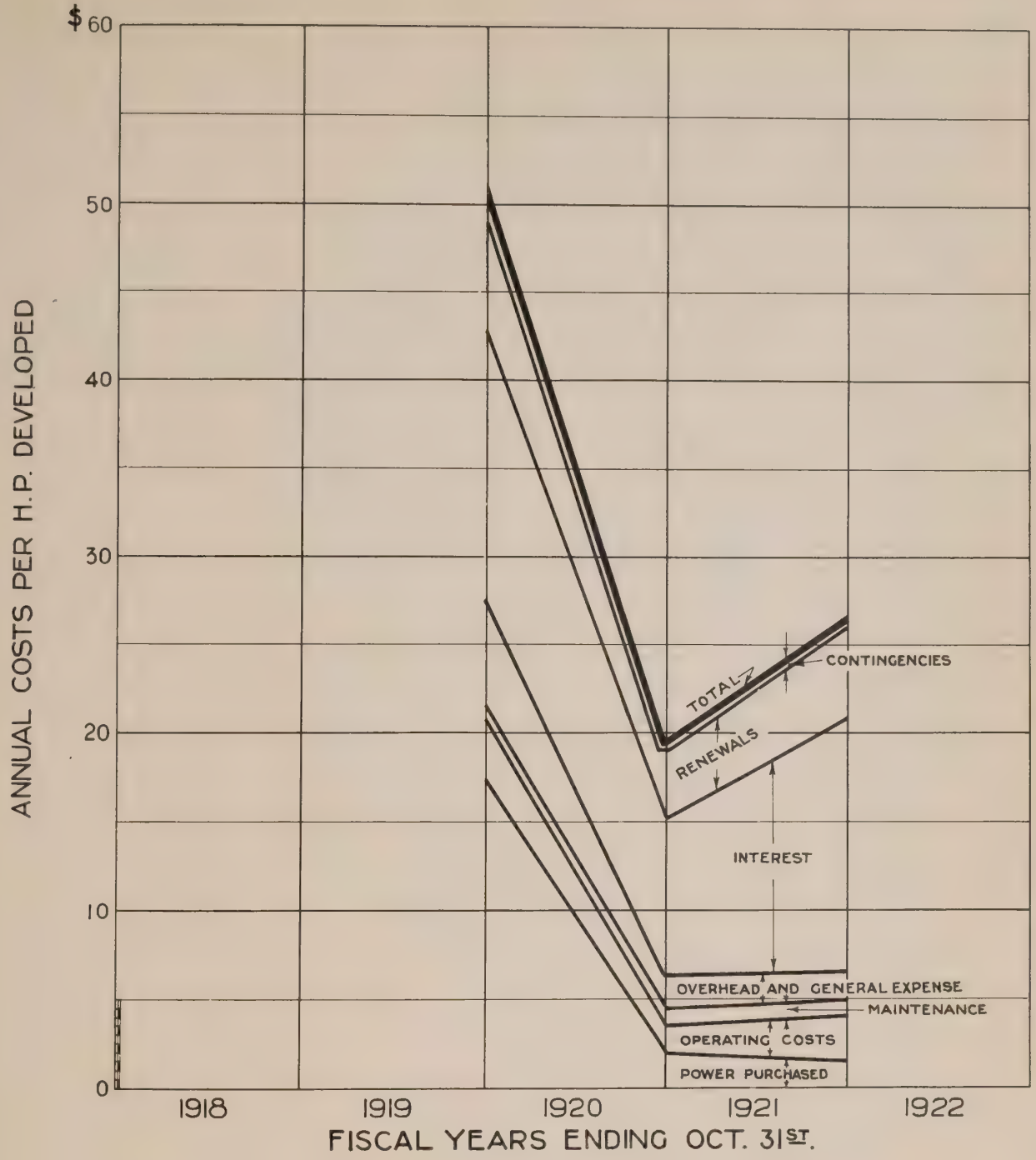
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

RIDEAU SYSTEM

TOTAL COSTS PER H.P. PER ANNUM
VARIOUS H.P. BASES

Toronto, Mar. 24th., 1923. Made by S.R.W. Checked by

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

RIDEAU SYSTEM

SUBDIVIDED COSTS PER ANNUM PER H.P. DEVELOPED

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WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Table of Total Costs per Horse-power per Annum

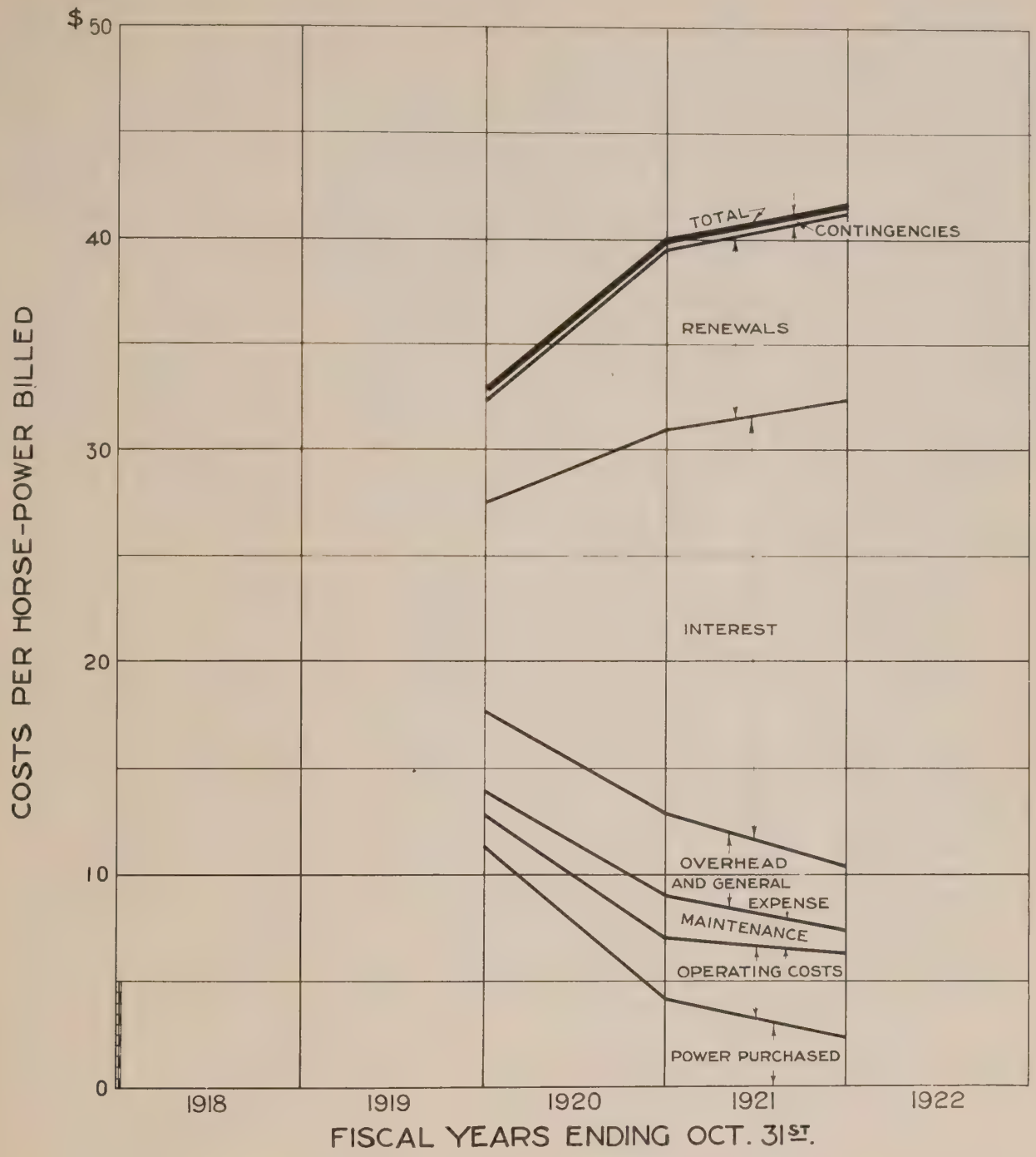
	Fiscal Years Ending October 31st, 1919	1920	1921
H.P.Developed	$31.12	$19.65	$26.69
H.P.Developed plus Purchased	22.72	17.19	24.08
H.P.Billed	32.92	40.02	41.76
H.P.Average of 12 Monthly Peaks	32.75	41.50	42.60
H.P.Maximum Yearly Peak	19.50	26.45	33.90

Table of Subdivided Costs per Horse-power Developed

	Fiscal Years Ending October 31st, 1919	1920	1921
Power Purchased	$17.51	$ 2.01	$ 1.52
Operating Costs	2.58	1.52	2.51
Maintenance	1.61	.94	.75
Overhead and General Expense	3.98	1.90	1.83
Interest	15.18	3.81	14.16
Renewals	7.87	4.35	5.76
Contingencies	.39	.12	.16
Totals	$31.12	$19.65	$26.69

Table of Subdivided Costs per Horse-power Developed plus Purchased

	Fiscal Years Ending October 31st, 1919	1920	1921
Power Purchased	$ 7.79	$ 1.76	$ 1.38
Operating Costs	1.15	1.33	2.26
Maintenance	.71	.82	.68
Overhead and General Expense	2.66	1.66	1.65
Interest	6.74	7.70	12.78
Renewals	3.50	3.81	5.19
Contingencies	.17	.11	.14
Totals	$22.72	$17.19	$24.08



HYDRO-ELECTRIC INQUIRY COMMISSION
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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
RIDEAU SYSTEM
SUBDIVIDED COSTS PER ANNUM PER H. P. BILLED
Toronto, Mar. 24th., 1923. Made by [illegible], Checked by [illegible]
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Table of Subdivided Costs per Horse-power Billed

	Fiscal Years Ending October 31st, 1919	1920	1921
Power Purchased	$11.27	$ 4.10	$ 2.38
Operating Costs	1.67	3.10	3.93
Maintenance	1.03	1.91	1.18
Overhead and General Expense	3.86	3.86	2.86
Interest	9.75	17.94	22.16
Renewals	5.08	8.86	9.00
Contingencies	.25	.25	.25
Totals	$32.92	$40.02	$41.76

Kilowatt-Hour Data.

The engineers of the Hydro-Electric Power Commission state that there is no record available of the total kilowatt-hours supplied to the Rideau System.

The tables below and on the following page show the kilowatt-hours per consumer for different purposes in the various municipalities of the Rideau System for the year 1921, and also show the kilowatt-hours consumed for two classes of lighting service averaged for the whole of the Rideau System from 1919 to 1921 inclusive. The figures indicate the difficulty of comparing one place with another, as will be seen by the wide variation in the details given for the various places.

Table of Power Consumption by Municipalities, 1921

Location	K.W.H. per Domestic Consumer	K.W.H. per Commercial Light Consumer	Horse-power per Power Consumer
Carleton Place	446	1,288	54.5
Perth	420	816	27.1
Smith's Falls	386	1,055	21.5
Lanark	-	-	3.2

Table of Kilowatt-hour Consumption - Various Classes

	Calendar Years		
	1919	1920	1921
Kilowatt-hours per Domestic Light Consumer	295	* 358	411
Kilowatt-hours per Commercial Light Consumer	940	*1137	1043

* excluding Smith's Falls

Summary.

A summary of a number of the more salient points which have been studied and discussed in the foregoing report may be of advantage in continuing the consideration of the economics of the Rideau System. They are as follows:

(1) The Capital Costs of the Rideau System contain nothing for intangibles unless the 75 shares in the Mississippi River Improvement Company, Limited, may be so classed; nor is anything included for undeveloped power properties.

The High Falls plant construction was undertaken in 1918 to supply a load demand which apparently could not be economically supplied in any other way. The plant was built during the time when construction costs were at their highest, but advantage was taken of the opportunity to purchase almost the whole of the electrical and mechanical equipment as used apparatus from the Hannawa Falls Power Company, Potsdam, New York, thus keeping the equipment costs at less than new equipment could have been bought for. The estimates were submitted in June, 1918, and construction was commenced in October, 1918, and completed in June, 1920.

The original estimates covered the cost of the High Falls plant and 22 miles of 22,000-volt transmission lines, the figures given for the whole being $340,000.

The transmission lines would ordinarily account for $40,000 or $50,000 of the estimate.

The actual construction costs were about $695,000 for the 78-foot head plant alone, without transmission lines. This represents $193 per horse-power based on the turbine rating of 3,600 horse-power, and $248 on the basis of the electrical horse-power rating of the generators. On the basis of the maximum demand of 1,840 horse-power in 1921, the capital cost is $377 per horse-power.

The capital cost of the Carleton Place 10-foot head plant purchased by the Commission is about $114 per horse-power for 535 horse-power capacity.

(2) Capital costs projected for the fiscal years 1922 and 1923, amounting to about $120,000, will make the total investment in the Rideau System approximately $1,200,000 at October 1923. This contemplated expenditure is stated to be for minor extensions and betterments at High Falls and other stations in the System. together with expenditures on account of rural distribution, but does not include the cost of the additional proposed storage improvements. The necessity for these expenditures should be determined.

(3) To facilitate future economic studies and to assist in operating efficiency, it would be well to consider keeping accurate records of kilowatt-hours used at each principal consuming point on the systems.

(4) The market for power has been well covered in the municipalities served. The density indicates a fairly high percentage of consumers per capita of population. The demand for electricity is apparently still growing and indications are that the other generating stations in the district, or other developments, must soon be looked to as further sources of power supply for the system. The ultimate demand for power and ultimate sources of supply should be considered in the near future because the local economical power sites will probably soon all be utilized.

(5) The reserve for renewals should be carefully considered in its relation to the recently estimated useful life for various portions of the property, and also adjusted to allow for the actual cost of money year by year.

(6) The reserve for contingencies has not yet been called upon to replace any losses due to damage of properties. The fund, however, is very small and might with advantage be increased, and yearly results noted so as to eventually devise a proper yearly allowance for the fund.

(7) The operating records indicate that the System is being operated so as to supply power at cost, there being no difference between total revenues and total costs as shown on the Commission's books.

Walter J. Francis

Consulting Engineer.

Toronto, March 24th, 1923.